FIREMAN'S GUIDE

REGION ONE

UNITED STATES DEPARTMENT OF AGRICULTURE
U.S. FOREST SERVICE
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CONTENTS

FOREWORD

The Fireman's Guide is a handbook of instructions; and contains specifications, practices, and techniques for the conduct of fire control work in Region One. It is designed primarily for use by the man on the job, and must not be confused with the Fire Control Handbook which deals largely with matters of policy.

The structure of this book, and some of its contents, were taken from the Region Five Fire Control Handbook. Alterations, deletions and additions were made to meet the requirements of Region One conditions.

REGION ONE FIRE CODE

1. *Prevention* thought and action shall be pointed toward that state of accomplishment where no fire shall result from the malice or negligence of man.
2. *Preparedness* will be maintained to that degree required to cope with the most difficult situation probable under existing or predicted conditions.
3. *Detection* must embody complete dependability, constant vigilance, utmost accuracy and maximum speed.
4. *Smokechasing* should have for its object the earliest possible arrival at point of attack.
5. *Suppression* action shall be designed to effect application of sound tactics and techniques, and to provide facilities in proper kind and amount at the correct time and place.

Section I

INTRODUCTORY INFORMATION

PURPOSE OF THE HANDBOOK

1. To set forth those practices which will be of greatest assistance to the fireman in the conduct of his work.
2. To establish standards of performance for those men who do the work, and those who direct and plan.
3. To provide for field men a brief description of practices, tactics and techniques resulting from the experiences of hundreds of men on thousands of fires.

USE OF THIS HANDBOOK

1. This book is designed to serve as a general guide in fire control work for all employees of the Region. Supplemental instructions will be issued by local executives to meet the detailed local requirements of each position.
2. Copies of this book will be placed in the hands of all men directly responsible for work in prevention, presuppression, and suppression.
3. Each fire control employee will be expected to become familiar with that portion of this book which applies to his position, or to any job to which he is likely to be assigned.
4. The examples and problems included herein will have most value if the reader will visualize them in country he knows well, on a fire he has fought, or in a situation he has encountered. Think of the Handbook in terms of your own job.

STRUCTURE AND INDEXING

1. For the convenience of the reader, this book is compiled in four sections.

   Section I. Includes introductory information necessary to comprehensive use and understanding of this book and its purpose. It includes a brief description of the organization, line of authority, and responsibilities in Fire Control; and a definition of fire control objectives.

   Section II. Sets forth the normal requirements and duties of the lookout, fireman, patrolman and other positions responsible for fire protection duties. It includes job descriptions and detailed problems in detection and suppression of small fires.

   Section III. Deals with suppression of large fires. Much detail of technique is omitted in this section since it is adequately covered in the preceding section, and is applicable here without repetition.

   Section IV. General informative material necessary to proper conduct of fire control work. Includes material directly related to topics in both preceding sections, but is segregated in the form of reference material to avoid repetition.

2. All four sections of this book are combined in one index. Each chapter or topic is indexed exactly as titled. For convenience in finding material, the index includes certain subjects within a topic which may not be adequately indicated in the title.

OBJECTIVES IN FIRE CONTROL

FIRE PREVENTION

To accomplish a reduction in number of man-caused fires to the lowest practicable minimum at the least cost, and to reduce the danger of serious fires by elimination of hazardous fuel bodies.

The accomplishment of this objective will require the utmost effort on the part of every forest officer. It will require constant application of known effective practices, and a keen alertness for new means and methods. With the exception of fire suppression and presuppression, fire prevention has priority over all other work in Region One. There is no honor due a forest officer for suppressing a fire that he should have prevented.

Methods and instructions for conduct of prevention work are treated in a later section of this book.

PRESUPPRESSION (Preparedness)

To have in position for immediate action adequate personnel, equipment, and other facilities required to meet the needs of existing and impending fire danger in accordance with established suppression requirements.

In order to be prepared, every member of the organization must know his job thoroughly. He must know the instructions pertaining to his own job and those governing the men under his supervision.

There is one best method for doing each job in fire control, and each man must be prepared through training, instruction, experience and attitude to do his part of the job in that best way.

Responsibility for preparedness has no holiday when there is fire danger. It must be maintained 24 hours each day if we are to be successful in fire control.

SUPPRESSION

To control all fires burning under possibly dangerous conditions within the first burning period, or not later than 10:00 a.m. of the day following discovery. When control is not effected by 10:00 a.m. of the day following discovery, plans for attack on each succeeding day will contemplate control before 10:00 a.m. To reach this objective every man responsible for any part in fire suppression work must at all times be prepared to meet the most severe fire situation probable under prevailing or predicted conditions.

Fire suppression has priority over all other activities.

REGION ONE FIRE CONTROL ORGANIZATION

This Region annually experiences 1,500 to 2,000 fires. Suppression of these fires affects the work of nearly every member of the entire organization, whether or not they are regularly assigned to fire control positions. In times of emergency every able-bodied man in the Region is subject to call for fire assignments commensurate with his qualifications. Likewise, on a national forest, the entire personnel from laborer to supervisor play a part in fire suppression activities. There are instances where men from two or several different forests and the regional office are organized into one unit to assist the local ranger on a fire. In fire control work there are no ranger district, forest or regional boundaries. The entire strength of one unit is, at all times, available to help a distressed neighboring unit.

The practice of assembling men from different locations makes necessary the adoption of uniform standards for fire organization. To avoid confusion and misunderstanding, lines of authority and responsibility must be maintained in identical form on all ranger districts and forests. Briefly stated this line of responsibility is as follows:

THE REGIONAL FORESTER

The regional forester is responsible to the Chief Forester for all fire work in the Region. The regional office delegates full authority and responsibility for management of fire control to the supervisor of each forest, who exercises such authority for all action within his forest. The regional office acts as a coordinating agency and a service headquarters for the forests. It is here that the needs of the forests are considered, and general fire practices are coordinated. The regional forester and his representatives inspect forest organization and fire action with a view toward assisting the supervisor to maintain adopted standards, and to assist in training of fire control people. Likewise, such inspectors learn of new and improved methods, and carry them on to other forests. Another regional office function is to see that each forest receives its just share of fire control facilities, and that such facilities are put to the best use possible. The regional office acts as a central dispatching agency in mobilization of inter-forest personnel and equipment, and handles such all-region fire projects as development of major items of equipment, management of central fire caches and the packstock depots. The regional forester does not take charge of fire action unless specifically requested to do so by the supervisor. His office develops standards, coordinates practices, establishes policies and inspects the performance of the seventeen national forests.

THE FOREST SUPERVISOR

As administrative head of the national forest, the supervisor is responsible to the regional forester for all fire control work on his forest. He delegates full authority to his rangers for all direct action in all phases of fire control, and holds them responsible for accomplishment in accord with established standards. He assists and directs his rangers through training and inspection of their work. He inspects guards and guard camps, not to check up on the guard, but to measure the accomplishment of the ranger. He acts as coordinator of inter-district activities and mobilization, and serves as councilor and guiding supporter to the ranger in emergency problems. He interprets regional instructions and policies, and sees that rangers carry these, as well as local instructions, into effect. He directs major campaigns in fire prevention with the assistance of his rangers. On large or difficult fires, the supervisor does not usurp the authority or responsibility of the ranger. Instead, he uses this opportunity to further the experience and training of the ranger by making him "fire boss" and himself supervising the action only to the extent necessary to prevent major errors in management and to train the ranger or other fire boss. Of course, when fires occur which involve management clearly beyond the ability of the ranger, the supervisor will assume direct charge. Such instances are few. All requests for fire control facilities from central caches, or from other forests must be approved by the supervisor. Likewise, he is responsible for furnishing assistance to other units whenever possible without endangering his own forest.

THE DISTRICT RANGER

The direct burden of fire control falls on the district ranger. He is responsible on a certain allotted area for all lines of protective work, prevention, detection, and control; as well as for all administrative and other work on his district. During the fire season the district ranger should be in the field where he can keep in close touch with his field forces and give personal direction to a large part of the work.

When fires are burning he is expected to take a direct part in their suppression, taking charge of Class C fires unless or until relieved by higher authority. A ranger has no more important duty than to be on the fire line of as many fires as physical limitations permit.

The district ranger is normally the responsible administrative head of the fire organization on his district and all men working within his district, includng those in charge of fires, are responsible to him.

He will direct, as fire boss, the action on as many fires as possible. He will often be called upon to direct in a general way and coordinate the action on several fires. He may, when necessary, delegate a dispatcher, a ranger alternate, or a detailed forest officer to act for him; preferably in such a manner as to free the district ranger for supervision on the line.

Unless otherwise specified in individual cases, the following procedure will obtain: All orders for overhead, men, transportation, equipment or supplies will be placed through his office; and, likewise, all reports of progress will be made through his office. Questions in regard to policy, procedure, methods and personnel on fires will be referred to the ranger or his designated alternate.

The ranger is directly responsible to the forest supervisor for all fire control activity on his district.

THE RANGER ALTERNATE

The ranger alternate's duties are very similar to those of a ranger; often the same. They are varied and cover a wide range of activities. While the alternate will be under the direction of the ranger the greater part of the time, it is essential that he be a high calibre man, mentally and physically fit; with essential training, experience and proper attitude to qualify him to act upon his own initiative.

The alternate's qualifications, in matters of fire control work, should be comparable to those of a forest ranger.

He is primarily a fireman, and as such must be given training comparable to, if not the same as, that afforded forest rangers. This position is highly important in the organization when it is realized that even if all regular officers were thoroughly competent fire executives, there would still be too few to meet the demands of critical situations.

The alternate is directly responsible to the district ranger.

THE DISPATCHER

Fire forests recognize the need for highly qualified ranger district dispatchers whose qualifications and responsibilities are comparable to those of the field alternate. Ordinarily this member of the organization is assigned to ranger headquarters during the fire season; and it is his job to keep the district records, make necessary reports, keep in close touch with each district employee and conduct fire action under direction of ranger or alternate, if present, or upon his own initiative in case of the

absence of both. In order to satisfactorily handle fire dispatching, it is essential that this member of the organization be an experienced lookout-fireman and have personal knowledge of the area with which he is concerned. Experience in suppression of large fires is also necessary to complete understanding of this work.

THE HEADQUARTERS GUARD

There may be a few cases where the volume and character of work at ranger district headquarters during the fire season does not require an assistant to the ranger of ranger alternate or ranger dispatcher calibre. There are other cases where the volume and character of work is such that an assistant to the dispatcher is required.

In either case the position, termed as headquarters guard, will have responsibilities approaching those of an alternate or a dispatcher, except that they may not be called upon to make field inspections or supervise protection men or improvement crews.

Ordinarily the headquarters guard is in reality a second dispatcher or alternate in training.

THE LOOKOUT-FIREMAN

This position, under the supervision of the ranger, embodies the last and final breakdown in territorial assignment for fire protection. It is the lookout-fireman who ordinarily is responsible for detection and first suppression action on the ground. The importance of his position is illustrated by the fact that some sixty percent of fires are handled entirely by him. Each of these fires is a potential disaster, hinged upon the competence and performance of the lookout-fireman.

As a rule, this position is filled by younger men who have been developed as woodsmen through assignment to improvement crews, surveys, etc. A great number are selected who have had no experience in woodcraft. These must be given an opportunity to become skilled in woods work, forest activity, and travel necessary to successful smoke-chasing.

Selection of lookout-firemen should give consideration to (a) the physique of the individual—he must be sound in health and alert of mind, (b) ability of the applicant to develop to higher responsibilities, (c) number of years applicant may be available and the amount of training and experience required to qualify him for the job.

THE CREW FOREMAN

Each forest crew foreman has a definite responsibility in fire control. He is not only responsible for his own training and performance in fire duties, but also for that of his crew members.

Ordinarily the foreman is responsible to the district ranger and is provided with specific detailed instructions concerning his project work. His fire work, except for certain local duties, is covered in later sections of this book. Much of the success in fire control rests upon the judgment and performance of the forest foreman since he often leads and directs the first attack on fires. Likewise, the forest project crew is a training school for lookout-firemen, crew foremen and straw bosses, and the foreman is responsible for laying the foundation for advancement of these men.

It is in the regular forest crew that men learn to use tools, to acquire knowledge of what constitutes a reasonable day's work, to work harmoniously as a unit with

others, to receive instructions and carry them into execution; and it is here that firemen first learn the feel of foremanship and thus acquire the foundation for sympathetic management of such personnel as may later be under their supervision.

The forest foreman must know the principles of organization and the tactics and techniques prescribed for fire prevention, preparedness and suppression in this book.

THE PREVENTION GUARD

The prevention guard is ordinarily responsible to the district ranger but under certain conditions may work on two or more ranger districts. Likewise there are situations when due to geographical location of prevention problems he may work under direction of the supervisor's office.

His primary duties are to prevent fires. He has responsibility for teaching forest users to properly handle fire in the forests, to exercise tactfully the police authority necessary to obtain compliance with fire laws and to obtain evidence for prosecution of violators. The prevention guard is the Forest Service Representative to the visiting public and as such he is responsible for obtaining from all persons contacted a willingness to cooperate in preventing fires. Likewise the prevention guard is responsible for detection and suppression of fires. His special duties will be definitely stated in local instructions written to meet individual problems of the job. The general instructions in this book shall govern activities of the prevention guard in preparedness and suppression work.

THE PER DIEM GUARD

The per diem guard works under direction of the district ranger. His responsibilities are comparable to those of the lookout-fireman and insofar as preparedness, travel and suppression jobs are concerned, the instructions and responsibilities specified in this book for lookout-firemen are applicable.

The per diem guard position differs from that of the lookout-fireman's only in that it is not a full time job. He functions only during periods when there are fires or special dangers. He usually is a rancher, forest operator or permittee, whose day to day work is not under direction of the forest service. His is an important role and one valuable to the fire control job.

Section II

SECTION II

This section deals with general instructions to fire control employees. It applies to all employees who have responsibility for fire control work. It shall govern in determining standards of performance in the various jobs, both by the men who do the work and by those who direct, supervise and inspect.

Regardless of the manner of expression used, which in this Handbook has purposely been made brief and pointed, it is understood that the practices enumerated are things which are to be done or known or avoided, as the case may be, and against which men's work will be checked and their qualifications rated. Some things may seem of minor importance, almost trivial in fact, but it is to be remembered that big jobs are the sum of little things, and that big issues often turn on success or failure in the handling of details.

GENERAL INSTRUCTIONS

The practices listed here represent the best thought and judgment of men of long experience. Each item has been carefully weighed and checked for its soundness and value in fire control work and in the whole job of administration, protection and utilization of National Forest resources. However, no set of instructions and specifications can be issued to meet the full requirements of each man's position. Much of the detail of individual jobs is left to the judgment of the individual. In many instances the employee will be faced with problems completely outside the scope of these instructions and his experience. On his decision and action will rest the success of the job and the reputation of the organization. To cope with such situations the man must rise to the occasion without hesitancy and expand his thought and action into new fields. He must see more than he looks at. He must see the whats, whys and particularly the hows involved. He must have and use imagination but keep it within reasonable control. He must maintain the attitude that the job can somehow be done and where prescribed rules, instructions and advice do not cover the task at hand, he will draw on his imagination for possible solutions. When he hits upon a likely idea, he should think through to the possible results, weighing the chances for success against those for failure. Sometimes it may be necessary to play against odds, to take the one chance of success where there appear many for failure. Judgment plays a tremendous part in fire control. Good judgment is nothing more than sound, logical reasoning, and is derived from the evaluation of factors and elements of the problem, knowledge of the fundamentals of the game and a controlled imagination which rationally visualizes the process and the results.

Each employee having fire control duties of any kind shall familiarize himself with and carry out all the instructions herein pertaining to his jobs, and cooperate fully with every other member of the organization in the prevention and suppression of fires. Loyalty, teamwork, speed, will and a determination to get every fire will go far toward gaining mastery over fire.

These instructions are divided into several parts: general instructions applying to all employees, job requirements, instructions applying to special classes of work, methods, techniques, definitions, examples, etc.

RELATIONSHIP WITH PUBLIC

All Forest Service employees are employees of the public. Every citizen of the nation is a stockholder in the national forests and as such, is officially entitled to respect and courtesy. Greater by far than this official element is the personal relationship which is more important to success in fire protection.

Forest visitors are interested in something the forests offer, else they would not be there. They are more than share holders; they are forest users and are harvesting some product of the forest, whether it be scenery, fishing, timber or grass. They have a personal stake in the game of fire protection and all are potential cooperators. Their value as cooperators depends upon their knowledge of fire protection and their attitude toward the forest employees. Both their attitude and their knowledge is built up through their contacts with guards, rangers and other forest officers. Thus, forest employees must keep two objectives in mind in all contacts with the public: First, to cultivate a friendly relationship and promote the spirit of cooperation in preventing fires, and, second: To teach forest visitors how to be good cooperators.

Means by which this can be accomplished are:

1. Meet and deal with all forest visitors in a helpful, cordial, courteous manner. *Cultivate friendliness.*
2. Handle all business with visitors in a frank, straight-forward, businesslike way. *Invite respect.*
3. Explain your job, the reason for fire protection and how both affect the things in which the visitor is concerned. *Develop interest.*
4. Determine what the visitor knows about the safe handling of fires, being ever careful not to offend. Learn in what respect he needs training. *Analyze needs.*
5. With as little appearance of salesmanship as possible, explain, instruct and demonstrate the things the visitor must know and do to be an effective cooperator. *Train the visitor to handle fire properly.*

SMOKING

Fires resulting from careless smokers have been responsible for the greatest number of man-caused fires. Each year more and more people use the forests and the job of preventing smoker fires grows bigger each season. Every forest employee must aggressively attack this job.

Each employee is expected to know the rules that apply to smoking and must abide by them strictly. Must know how to handle matches and tobaccos with entire safety and teach visitors the need for and how to make certain their match and tobacco is dead out before being discarded. Smoking rules must be rigidly enforced.

CAMPER FIRES

The development of roads and trails has opened the forests to use of campers, picnickers and other people who must use camp fires to fully enjoy their visits. While camping and campfires are a necessary part of forest use, each campfire is a potential source of disaster unless properly handled. The job of the forest officer is to teach people how and why to use campfires safely, and to see that such practice is followed.

Relatively few visitors realize the dangers involved in starting campfires. They should be taught to recognize the following dangers and how to avoid or eliminate them.

1. Campfires under trees likely to set fire to moss or needles and quickly become a forest fire.
2. Ground around fire not cleared of all inflammable material to mineral soil. Fire likely to smoulder and creep into forest fuels.
3. Fires exposed to wind, or close to forest fuels are likely to throw sparks and cause forest fires.
4. Fires built against logs, stumps or trees are difficult to extinguish and likely to spring to life after camper leaves. Large campfires create their own draft and are likely to carry sparks into forest fuels and thereby start forest fires.
5. Incompletely extinguished campfires and ashes from camp stoves are the greatest source of trouble. Camper should know how to use water and dirt to put his fire dead out. Stir, mix and feel.

LAW ENFORCEMENT

One of the most effective means of reducing man-caused fires is through strict enforcement of fire laws and forest regulations. Every forest employee is charged with the enforcement of these laws. The final result and success of his actions in law enforcement will depend upon the way in which he conducts this part of his duties.

All law enforcement must be impartially and impersonally handled. It must be aggressively and positively conducted. Society has outlawed carelessness with fire in the forests and the sentiment of the public in general is on the side of the law enforcement officer.

All forest employees are expected to:

1. Be familiar with the fire laws and regulations of the forest and state of his assignment.
2. Tactfully inform the public regarding these laws.
3. Be constantly on the alert for violations.
4. Immediately take action where violation is discovered.
5. Obtain from ranger at beginning of season, information on state and forest laws applying to territory of assignment.

MAKING ARRESTS

Forest officers and employees are empowered by federal statute to make arrests without warrant for offenses against national forest laws or regulations *committed in their presence*. With a warrant arrests may be made for such violations made in or out of their presence. Only in rare cases is it necessary to make arrest without warrant. It is safer whenever possible to secure a warrant from a justice of the peace or from a United States Commissioner and use it as visible sign of authority for arrest.

Federal fire laws and regulations are applicable only on national forest lands. Certain state forest fire laws apply to all national forest, private and state forest lands. Forest employees are responsible for enforcement of state as well as federal fire laws within the territory over which they maintain fire protection.

Prosecution of violators can usually be accomplished more quickly and with less cost to the public, in state courts than in federal courts. Therefore, whenever possible, arrests should be made on state charges.

Making arrests is an important part of law enforcement and as such is a necessary duty of forest employees. If properly managed arrests are neither offensive to the violator nor embarrassing to the officer.

Things to Do When Violation of Law Is Discovered:

1. Maintain the attitude that law enforcement action is a duty and that the forest officer has no choice but to redeem his responsibility.
2. *Be certain that a law or regulation has been violated and know what law, federal or state.*
3. Collect all the evidence available which will point to the identity of the violator and the nature of the violation.
4. Make certain that evidence is accurate in detail. Use measured distances, recorded time; complete names and addresses of both violators and possible witnesses; definite legal descriptions of locations; photographs; recorded car numbers; described or measured tracks; collection of papers, cigarette or match stubs, food containers, cloth or other articles left at site by violator. Chips of wood cut by axe or knife of violator are valuable. Obtain names and addresses from fishing or hunting licenses if in doubt.
5. Immediately report findings to ranger or supervisor's office.
6. When violation committed in presence of the employee, arrest should be made without warrant if there is likelihood that violator will otherwise escape prosecution.
7. In making arrests: Approach violator with an attitude of friendliness. *Law enforcement is official business and should be conducted free of all personal feeling.*
8. Be firm and businesslike, but be human always. Arrogance or offensiveness is detrimental to the cause of fire prevention and cannot be tolerated.
9. Never argue or quarrel with the violator. Argument is the prerogative of the court.
10. Do not impose hardship or unreasonable inconvenience upon the violator. The judge and not the arresting officer is empowered to prescribe penalty.
11. Handle arrests without loss of dignity to yourself or the Service, yet in a way that will cause the violator to feel that he has been treated firmly and with entire fairness.
12. A proof of successful law enforcement occurs when the violator pays his fine, then shakes the hand of the arresting officer.

SANITATION—HEALTH

Forest Service employees shall set a high example of cleanliness and sanitation practices for all forest users and keep themselves physically fit.

This applies at:

Headquarters.	Habitations.
Any cabin.	Tent camps.
Lunch places.	Camp grounds.

Other occupied sites.

Standards Require:

Personal neatness.
Neat and appropriate clothing.
Shave at least every second day.
Clean towels.
Keeping fit, exercising regularly.
Regular well-cooked meals. (Poor cooking is inexcusable.)
Ample garbage pit 100 feet or further from kitchen, current disposal therein.
Frequently disinfected toilets and garbage pits.
Clean windows.
Washing dishes directly following each meal and rinsing in clear, hot water.
Fly-tight pits and garbage cans.
Station grounds cleared of all rubbish.
Sweeping out daily.
Airing bed and quarters weekly.
Orderly housekeeping generally.

REDUCTION OF FIRE DANGERS

Stoves:

Not less than 18 inches from any wall.
Metal underneath extending 18 inches in front of fire box.
Ventilated space of at least four inches between stove and floor.
Close tightly before leaving.
Dump ashes in prepared and safe spot, out of sight of grounds and six feet from any inflammable material. Avoid wind-swept places.
Bottomless fire boxes are dangerous any place.

Powder and Caps:

Pad well for packing or hauling. Mark package plainly. Box and handle separately.
Store separately in cool, dry, isolated well-marked place, at least 300 feet from other buildings.
Keep safe from stock, game or rodents. Damage to powder—poison to game.
Use of fuse prohibited during Class 4 or higher fire danger.

Pipe, Stove:

Provide standard screen or spark arresters. Keep all joints tightly fitted.
Joints shall be riveted where practicable. Replace rusted joints promptly.
Project not less than two feet above ridge pole or roof comb, anchor securely.
Keep at least one foot from walls and three inches from roof or ceiling.
Use standard roof jacks and wall and ceiling drums.
Oil and store in dry place in fall. Put cap on roof jack at end of season.

Spark Arresters for Chimneys and Stovepipes:

Each chimney or stovepipe used within 500 feet of forest fuels, rating above the low spread type, must be provided with spark arresters during dangerous fire weather. (D.C. 4.0 and over.) The "Region Five Dwelling Spark Arrester" is considered to be the best available arrester and is standard in Region One. Tent or other temporary camps in which stoves are used are usually a source of danger, since they are often located in the midst of heavy fuels and complete clean-up of adjacent grounds is not feasible in view of the short period of occupancy. Therefore, particular attention must be given spark arresters in such camps.

Chimneys Dangerous When:

Cracked.
Leaning.
Unscreened.
Concrete.
Not cleaned.
Not two feet above roof comb.
Pipe openings uncovered.
Supports are weak.

(Inspect monthly and repair as deficiencies are found.)

Gasoline, Oil, Coal Oil:

Store in cool, dry place, 100 feet from occupied buildings.
Do not smoke or permit exposed flame near these.

Oil or Paint Rags:

Burn up in stove immediately after use to avoid danger of spontaneous combustion.

Matches:

Place in covered glass or tin container. Keep out of sunlight and away from stove.

Glass:

Sometimes focuses sun's rays, causing fire. Dispose of bottles and broken glass by burying.

Roofs, (Keep Free of):

Cleats, ladders or any objects that collect moss, leaves, needles or other inflammables.

Rubbish Burning:

By temporary employees only when approved by ranger.
Only in prepared spots cleared of all fuels for a distance of eight feet on all sides.
Only during safe weather. Extinguish all embers before leaving the fire.

Camp Fires:

Locate in open ground. Clear ground three feet on all sides of fire. Build only large enough for actual need, in hole dug for the purpose.
Must be attended by someone at all times.
Put *dead out* before leaving. Mix with water or dirt, stir and re-mix, feel with hands.

Car Muffler:

Cars and trucks must be equipped with standard mufflers and no cut-out used.

Moulding Hay or Manure:

May be a breeding place for flies or cause spontaneous combustion. Dispose of by burning if possible—if not haul or carry to place out of sight and scatter thinly.

Spark Arresters for Motor Equipment:

All gasoline motor equipment and mobile internal combustion engines operated by the Forest Service must be equipped with approved spark arresters during all periods when fire danger rates above Class 4. 0. Permittees, including timber sale operators, construction outfits, etc., likewise must use spark arresters on gasoline tractors and steam engines while on the national forests.

TOOLS AND EQUIPMENT

The employee is responsible for all tools and equipment assigned him.

REPORT: Losses, breakages, worn out ones at once.

KEEP: Worn out and broken equipment for condemning by forest officers. Any property of the Forest Service not properly accounted for must be paid for by the person to whom it is charged.

Tentage:

Set up neatly.
Top level.
Ropes tight.
Walls straight.
Equip with asbestos rings or metal roof jacks.
Bottom free from ground to prevent decay resulting from moisture.
Avoid sharp objects.
Protect from stove, pipe.
Dry before storage to prevent mildew.
Store in dry place protected against attack by rodents.

Fireman Equipment:

Always in assigned place.
Intact and tagged.
Light always ready.
Safe from rodents and insects.
Handles tight.
Tools sharp and clean.
Rations complete and useable.
Use only on fire.
Replaced or reconditioned immediately after using.

Water Bags:

During fire season keep soaked at all times and change water frequently.
When filled, hang up.
Protect from sharp instruments.
Dry before storage.
Store in dry place.

Kitchen Equipment:

Wash and dry after use.
Rinse off soapy water before drying.
Neatly put away after using.
Coat with mineral oil for winter storage. Store in dry place.

Cars and Trucks—Government or Personal:

If used for fire shall be ready for instant get-away, and have:

Tires inflated to prescribed pressure.
Gas tank full.
Oil level up.
All lights working.
Grease-oil card on hand and up-to-date.
Card of instructions at hand.

Accident report forms in car.
Shovel, axe and water bucket.
Car jack, tire pump, repair kit and flares.
Spare tire and air up.
Brakes in working order.
License plates firmly attached and clean.
Battery fully charged.
Bearings greased.
All bolts tightened.

Driver Must:

Observe traffic and speed regulations.
Drive cautiously on curves and elsewhere.
Promptly report any accident on form provided.
Know that he may be held liable for damages resulting from accidents. All drivers of government vehicles must have public liability and property damage insurance, if driving 250 miles or more per month.
Be considerate and courteous to others.
Those who drive government cars regularly must obtain a government driver's license.

FOOD SUPPLIES

Have camp stocked on occupation for period of expected use.

Replenish through requisition from district headquarters. (This will not generally be at frequent or regular intervals.)

Order ahead of actual want.

Inventory supplies frequently, keep want list.

Send surplus items back to central storage warehouses.

Prevent waste of food.

Store neatly in cool, dry, protected place.

Keep away from animals, rodents and flies.

Fire guards, lookouts, etc., shall not be permitted to absent themselves from their station during possibly dangerous conditions to go after food supplies.

IMPROVEMENT WORK

Improvement work is an essential part of the fire control employees' duties. Do not permit maintenance and construction jobs to interfere with necessary fire control duties. During periods when there is fire danger the district ranger is responsible for seeing that this does not happen. Men with fire duties will leave their stations or engage in other than fire duties only under specific instructions issued daily by the ranger, or by his alternate or dispatcher when either of them has been designated by the ranger to issue such instructions.

KNOWLEDGE OF LOCALITY

The ranger will, to the extent possible, distribute pre-season work to employees to assist them in learning their country. He will direct discovery trips, discuss with the employee pertinent points about all areas in question, and indicate on a map or by memoranda helpful information. First-hand knowledge is the best. It is essential for each fire control employee to know his country.

The Knowledge Required Includes:

Roads and trails.
Topography—stream courses, ridges and peaks.
Natural fire-breaks.

Landmarks.
Stream crossings.
Character of timber stand.
Type of fuels in relation to spread of fires.
Special fire hazards—slash, abandoned buildings, timber operations, etc.
Best routes of travel away from roads and trails.

This information can be obtained through:
Study of maps. Trips into areas.
Information from those who know.

DIARY

Every employee is required to keep a daily notebook record of work and important occurrences. The first leaf shall show:

Name	John Doe
Lookout or other	Cook Mt.
District	Dixie
Forest	Kootenai

1940

For each day use one or more pages, but do not put more than one day on a page. Head page thus: (Sample for Lookout-fireman)

Wednesday, July 1

6:00 a.m. to 6:20 in observatory—looked area over intensively.

7:00 a.m.—Breakfast over, dishes washed and test calls to Bungalow Station.

8:00 a.m. to 1:00 p.m.—Helped Bill Head cut out 10 logs on Trail No. 10 between mile posts 1 and 4, returned to Cook Mt. 2 p.m.

2:05 p.m.—Reported Bungalow Station. Received weather forecast of probable electric storms. Told by Brown to go on lookout duty.

3:00 p.m.—Thunder clouds appearing over Rocky Ridge, traveling NE wind 15 miles per hour. I reported this in.

3:15 p.m.—Lightning over Weitas Creek with light rain. Several strikes located, recorded and reported to headquarters.

3:45 p.m.—Storm passed over Moose Mt.

3:50 p.m.—Richard Roe trail maintainer came in from Indian Grave.

3:55 p.m.—Thin smoke appeared azimuth 280 degrees Sec. 5, T. 2 W., R. 14 N., reported this to Brown, dispatcher at Bungalow.

4:00 p.m.—Started to fire. 4:58 p.m.—arrived at fire. 5:25 p.m.—controlled fire. Put fire out at 7:10 p.m., filled out smokechaser report form and left 8:20 p.m. Returned to lookout at 9:50 p.m., reported at once to headquarters. Richard Roe attended lookout duty during my absence.

Maint. Trail No. 10—5 hours. Fire No. 8—6 hours.

(Sample for Crew Foreman.)

Chas. Briggs, Trail Crew Foreman.

7:00 a.m.—Breakfast over, telephone test call made to O'Hara Station, all okay.

8:00 a.m.—Started 6-man crew rebuilding trail up Ratclaff Creek, 2 men swamping, 4 men grading tread.

1:10 p.m.—Messenger called crew to O'Hara because of forecasted probable lightning storms.

2:00 p.m.—Lightning occurring on Coolwater ridge with light rain, fire reported 2:30 p.m. Sec. 6, T. 32 N., R. 8 E., took 2 men in car. Left at 2:35 p.m. Drove to point ½ mile of fire, arrived with Short and Jones at fire 3:25 p.m. Fire controlled at 3:40 p.m. Fire out at 4:10 p.m. Made out Smokechaser Report Form 592 on fire and arrived at O'Hara 6:30 p.m.

Work on Trail No. 43—4 hours.
Suppression Fire No. 61—5 hours, 30 minutes.

DESCRIPTION OF JOBS AND RESPONSIBILITY

THE RANGER ALTERNATE

The ranger alternate's job in fire control is very similar to that of the ranger since, as in other district work, he must be prepared to take the ranger's place at any time. *He must be able to:*

Gain the respect and support of the district employees.
Assume charge of all fire control operations as directed by ranger.
Instruct and train temporary employees in their duties.
Inspect work of employees and correct errors.
Do any field job required in fire control work on the district.
Make suggestions for improving fire control plans and practices.

He Must Study and Become Familiar With:

- Forest Service fire control policies.
- That portion of the District Fire Control Plan including:
  - Fuel type maps and overlays.
  - Transportation system maps.
  - Index maps.
  - Detection responsibility maps.
  - Detection coverages.
  - Patrol coverages and scheduled trips.
  - Smokechaser responsibility maps.
  - Smokechaser travel time coverages.
  - Man-power placement maps and tracings.
  - Communication maps and tracings.
  - Organization, improvement and equipment plans, manning policy, etc.
  - Instructions to each man in the organization.
- Those portions of the Fire Control Handbook that pertain to his job.
- Fire Dispatcher Action Record and Dispatcher Guide Charts.
- Azimuth circle and parallel rule functions.
- Fire problems of his district, special hazards, etc.
- Forest procedure in regard to:
  - Allotments.
  - Expenditures.
  - Records and reports.
- Fire Danger Chart and the Forest Fire Danger Meter.
- Methods and requirements of taking fire danger measurements.

His Principal Fire Control Duties Include:

- Instructions and training of fire control employees both in training camps and on the job.
- Inspection of fire control stations, crews, fire packs, caches and *fire action* of any nature.

Report on the form provided complete findings and action taken by him on all inspections.
Taking corrective action wherever needed.
Seeing that permittees comply with fire control requirements.
Instructions and assistance to cooperators.
Action on going fires.

In the Absence of the District Ranger It Is His Duty to:

Assume charge of the district organization.
Keep the men in the fire organization alert and ready.
Work with the dispatcher in getting correct, speedy fire action.
Handle all reports and district work as scheduled.
Keep close daily contact with all district personnel.
Promptly advise the ranger or, in the ranger's absence, the supervisor of any important developments.
Take charge of any fire that gets beyond control of first-line forces, unless relieved by the ranger or supervisor.
When large fires occur the alternate must act quickly on his own responsibility.

If he cannot get in touch with the ranger, he should lose no time in taking the following action:

Completely calculate the probabilities (Fire Dispatcher Charts and Action Record).
Dispatch men, supplies and equipment commensurate with the job.
Provide transportation, and where necessary *lunches,* meals and lodging for men while en route to the fire.
Decide on special equipment and order if needed.
Have the fire scouted before arrival of crew.
See that fully adequate overhead is provided. There shall be no hesitancy in calling the supervisor for overhead if the district cannot supply it as quickly.
Provide guides for crews en route to fires.
See that all routes are plainly marked at intersections of roads and trails.
Provide necessary communication.
Provide for necessary follow-up action, and take direct control of action in field.
(See "Fire Boss Job Description" fire suppression chapter of this Handbook for further details.)

Responsibility:

The alternate is responsible for action taken by him in the same degree that the ranger is.

He Is Accountable to the Ranger for:

Compliance with outstanding instructions.
Adherence to his schedule of work.
Promptly reporting failure or weakness in the organization.
Taking necessary corrective measures.
All actions taken by him.

Complete cooperation between ranger and alternate can be brought about by:

- Current written instructions by the ranger.
- Frank discussion of plans, jobs and methods as questions arise.
- Interchange of copies of inspection records.
- Current memorandums and reports.
- Trip plans for the alternate coordinated with the ranger's.
- Definite, clear-cut job plan and assignment of authority.

DISPATCHER (RANGER DISTRICT)

The dispatcher is the ranger's assistant at the headquarters station and has certain administrative and fire control duties to perform.

The Dispatcher Must Be:

- Mentally alert and able to decide and act quickly and surely.
- Willing to work long hours, day or night when fires occur.
- Physically able to do hard manual labor.
- Able to do clerical work, keep records, charts and make reports.
- Qualified for lookout and fireman's positions.
- Generally familiar with improvement work.
- Familiar with the district in which he works (the more detailed his knowledge the better).
- Thoroughly informed on the communication and transportation systems and problems affecting travel to fires.
- Always courteous to forest users and visitors, as well as pleasant in dealing with employees of all classes.
- Thoroughly acquainted with the district fire plan and facilities for dispatching to fires.

Duties:

While the dispatcher is expected to do other administrative work, his principal job is fire control. Routine duties include keeping:

- Food supplies stocked to quantity required.
- Orders from field promptly filled.
- Current want list from various stations.
- Stock on hand invoiced and arranged in orderly fashion.
- Equipment repaired and stored in the place selected.
- List of equipment needs available for ranger.
- Fire cache and packs ready for immediate use.
- Fire control trucks and cars ready at all times.
- Useless equipment segregated for condemning.
- Ranger and alternate informed on everything requiring their decision or action.

Records and Reports:

- Dispatcher's daily log or diary.
- Data on "Dispatcher Action Record."
- Data on "Current Fire Record" (if used).
- Fires, by classes on district fire maps.
- Accurate fire labor costs and man-power by days.
- Meal records.
- Monthly district payroll to supervisor.
- Currently, occurrence and status of fires to supervisor.

· Supervisor's number for reportable fires.
Fire data to supervisor on Form 929 reports.
Daily fire weather and organization data as called for.
Additional information required by ranger.

Dispatching Duties Consist of:

Receiving and recording all reports on fires.
Checking to obtain any additional possible lookout readings.
Determining correct location of fire on map.
Informing ranger or alternate as soon as practicable.
Assigning men to go to fires as directed or as circumstances dictate.
Checking information with men before starting them to fires.
 Correct Form 17 R-1 data.
 Best route to fire.
 Accurate location on fireman's map.
 Correct compass backsight nearest visible lookout.
Calculating probabilities of spread and man-power needs on going fires in the absence of the ranger and alternate or when directed to do so by either of them.
Preparing necessary "Fire Dispatcher Action Record."
Initiating necessary follow-up action.
Keeping informed on any going fire.
Currently advising ranger and supervisor of conditions.
Taking immediate steps to re-man points vacated by men sent to fires.
Checking reserve forces and equipment that might be needed.
Recording all important facts and action taken.
Training lookouts over telephone by giving them problem fires, checking orientation and accuracy of reporting, map reading, etc.

General Duties Consist of:

Acting in charge of district in absence of ranger and alternate during which times he will be governed by instructions from ranger and alternate.
Receiving and making communication test calls.
Sending or receiving radio messages.
Keeping informed as to forest users.
Cheerfully dispensing information to inquirers.
Keeping informed on district activities.
Informing all stations as to time and fire weather forecasts.
Attending to any other clerical duties assigned by ranger.
Keeping headquarters office and yards clean and neat.
Recording fire danger measurements, weather forecasts and rainfall data.
Maintaining property records.
Bringing organization maps up-to-date by calling neighboring dispatchers each week and obtaining information regarding any changes in their organization which has significance to his district.

LOOKOUT-FIREMAN

The positions of lookout and fireman are usually combined in one man called lookout-fireman.

The instances where a man is hired solely for lookout work or fireman's work are very few. Since there are some such cases brought about by special needs for smokechaser coverage or detection coverage, the specifications and instructions for

lookouts and firemen are kept separate. The lookout-fireman is responsible for compliance with both sets of instructions.

THE LOOKOUT

Detection of fires is one of the most vital features of fire control. The lookout man is a key man in the fire control organization. As such he must be continuously on the job. No leaves of absence are granted during dangerous fire weather.

Quick control of fires and elimination of dangerous hangover fires require prompt detection, accurate location and intelligent reports promptly made to the dispatchers. Follow-up reports on progress of fires is an important part of the lookout's work.

The Lookout Man Must Have:

Good eyesight, strong and healthy physique.
Sufficient education and intelligence to make accurate observations, calculations and reports.
Alertness and be willing to work long, tedious hours.
Thorough knowledge of his territory.
Training in the details of his job.
Integrity—being on the job.
Skill in the use of all detection equipment.
Ability to distinguish between real and false smokes.
Carefulness.
Speed consistent with accuracy.

To Handle His Job Successfully He Must Be On the Job and Know:

Principles and use of the compass.
Use of the alidade and azimuth circle.
How to orient a mapboard or firefinder.
Map reading in all details.
Identification of physical features with map.
Weather measurements, reporting and use.
How to calculate areas of fires observed.
How to distinguish and record on his map all false smokes in his territory.
Lightning storm action, how reported.
Location of lakes, mountains, creeks, ridges, ranches, roads and trails within his range of vision.
What a small fire looks like.
Difference in appearance between smoke and fog.
Gauging the progress of a fire by the smoke column and by use of mapboard and alidade.
All details of fireman's job.
Communication and transportation systems of his area.
Where the danger areas within his territory are located and the extent and location of blind areas.

Equipment:

Each lookout shall be equipped with:

1. One of the four kinds of firefinders:

   (a) Osborne firefinder with map and azimuth circle.

(b) Bosworth firefinder with map and azimuth circle.

(c) Koch type which includes one baseboard, one mapboard, district map with azimuth circle and 18 inch alidade.

(d) Weholt type which includes baseboard, mapboard, district map with azimuth circle and alidade.

2. Complete fireman's pack.

3. A complete set of record forms which consists of:

(a) Lookout Fire Report Form 17 R-1.

(b) Diary book.

(c) Lightning storm report (if station is selected as observation point).

(d) Lightning strike record.

(e) Fireman's Report, Form 592.

(f) Necessary rain, wind gauge and other fire weather forms.

The equipment must be checked against this list for completeness. A tag listing the contents of the fireman's pack is attached to the pack. It must be used as a check of the completeness of the pack and a record of inspections.

Preparedness:

Advance preparation for fires is necessary. Fires often occur in groups over a period of a day or more. The lookout man must be prepared for long and continuous duty on the lookout or in going to fires.

Other men may be sent to work from his station to assist in covering all of the fires. On such occasions there is little time to do chores.

Everything must be in readiness for such emergencies:

Lookout windows clean and view unobstructed.

Mapboard base solidly set and working parts oiled.

Map clean and kept oriented, checked daily and before each reading, or series of readings.

Alidade sights with hair or wire always provided and in alignment—extra hair or wire on hand.

Firefinder clear of obstruction—not used for table or shelf.

Report forms and pencil readily at hand.

Telephone in working condition.

Test calls as directed by the ranger.

Mapboard light working—batteries strong.

Other lights—cleaned—filled—ready.

Fireman's pack complete and ready. (Water bag soaked and canteen refilled daily.)

Tools in proper condition for use.

Hand pumps if required oiled and near packs or attached.

Twenty-four hour water supply on hand.

Two weeks' wood supply—stove size.

Adequate food supplies on hand.

Car as specified in "General Instructions."

Saddle horses tied up and ready to go throughout daytime (7 am. to 7 p.m. if horse is required).

Lightning Storms:

The following points should be observed when lightning storms occur:

Report thunderheads to the ranger station when they appear.
Give location and direction the storm is traveling.
Pass the word on to other lookouts and dispatchers.
Have mapboard orientation checked and ready.
Be on lookout all during the storm, day and night; do not let meals interfere.
Watch continually for "hot" strikes.
Keep a record of the location of all strikes toward ground; use form provided.
Mark the locations on a map.
Telephone the information to ranger headquarters immediately.
Check all strikes on the record which develop into fires.
Watch the location of all strikes intensively during the succeeding days and nights.

Detection:

Detection work must be:

Systematic in procedure.
Accurate in each detail.
Unfailing in regularity.
Constant in alertness.

Minimum Requirements Are:

1. A systematic, complete, intensive observation of the visible areas consuming at least 20 minutes of each daylight hour during periods of danger. The ranger or alternate will schedule observations when he considers it necessary.
2. Observations must start at a given point and follow around clockwise to the starting point systematically viewing each ridge and canyon as it falls within the range of vision.
3. Scheduled night observations under detailed instructions by the district ranger when danger of fires justifies such action.
4. Means for orienting the firefinder at night. Distinct marks, coinciding with daytime orientation points, shall be placed on the walls inside the cabin.
5. Recorded bearings, location and description of all beacons, trash burners and other recurring smoke or lights.
6. A posted record of visible "false smokes" including all objects which may be mistaken for smoke, showing the section, township and range, azimuth reading and brief description.

"False Smokes" may include:

Distant rock slides.
Alder thickets on which light frequently resembles smoke.
Saw mill smokes, railroads, etc.
Fern patches.
Bodies of dead timber.
Dust—sheep, roads, etc.

Reporting Fires:

Accurate fire locations are necessary.
Complete information as indicated on left margin of the "Lookout Fire Report."

All of it is essential in dispatching. The information supplied by "Lookout Fire Report" shall give the dispatcher a true picture so far as possible of the fire as seen directly or indirectly from the lookout station.

Fire Reports by Lookouts Must Be:

Accurate.
Thoroughly checked.
Promptly communicated to dispatcher.
Supplemented by adequate additional notes of fire behavior as seen from lookout, *from discovery to time last smoke is seen.*

The Following Order Will Be Observed:

Notify dispatcher that a fire is seen.
Recheck map orientation.
Get azimuth reading.
Identify topography progressively from lookout to the fire.
Locate and spot fire on the map.
Check azimuth and location.
Fill in the Lookout Fire Report.
Telephone the information to the dispatcher.

Travel to Fires:

The lookout man is also a fireman, and it is his duty to go to fires when so instructed. (See Fireman's Instructions.)

Lookout Inspection:

The lookout man shall be furnished with the inspection outline used by forest and Regional Office inspectors. He will use this outline as a guide to inspect himself so that nothing will be missed in keeping his accomplishments to the desired standard. He will also check his own performance weekly in accord with the "Guard's Weekly Inspection Chart" shown in Section 4 of this book.

The ranger may and is encouraged to require each employee to make thorough periodic self inspections, and to fill out the inspection report form to be checked by the ranger or his alternate at the next visit made for the purpose of inspection and training.

In every case the inspector will furnish a copy of his report to the man inspected and will freely discuss both satisfactory and unsatisfactory items. Needed corrections will be made at the time.

Lookout Patrols:

Patrols on foot, horseback or by car are necessary from many lookout points to cover areas not otherwise seen. The district ranger shall issue written instructions and schedule designating the frequency of patrol trips, the regular or special equipment to be carried, the time consumed on each trip and places and length of observations.

The Minimum Requirements Are:

Patrol routes from each point to be numbered.

A sign posted at the take-off, with the name of the lookout point and number of the patrol, indicating the direction to take.

Patrol route plainly marked to observation point or points with blazes, tags or other adequate marks.

Provision at observation points of lookout trees, L-6 lookout towers or other structures to raise the observer above brush, trees, etc., when necessary.

Scheduled telephone reports to designated station while away from regular station.

The Ranger Shall Furnish Each Lookout Man With Supplemental Written Instructions Covering:

Patrols, frequency and time of test calls, responsibility zone, improvement work, water trips, emergency action and weather records.

THE FIREMAN

The Fireman Must Be:

Able-bodied with good eyesight.
Willing to stand hardships and hard work.
Qualified to do lookout work.
Able to take care of himself in the woods.
Acquainted with his territory and its topography in detail.
Trained in the details of his job.
In constant physical condition to undergo severe hardships.

He Must Know How to:

Read a map in detail.
Use the compass and map skillfully and find his way through the woods with them.
Use all communication facilities, instruments and devices available for his use.
Use axe, grub hoe, shovel and other equipment with skill.
Care for his tools and equipment.
Do trail and telephone line repairs.
Do his own cooking.
Size up a fire and plan where and how to attack it.
Fight fire under the various conditions probable within his territory.
Distinguish between mineral soil and duff.
Make a fire line safe.
Mop up inside the fire line.
Determine unfailingly whether a fire is *dead out.*
Cool down and stop spread of a hot fire by:
- Use of dirt in an effective way.
- Use of water where that is faster than dirt.
- Building the right kind of fire line. (Robbing fire of fuel.)
- Preventing fire from spotting or crowning.

The fireman will be held responsible by the ranger for immediate attack of fires to which he has been sent, and for the use of the best suppression tactics and technique in controlling and putting out fires.

He will go to fires outside of his district whenever the ranger, alternate or dispatcher requires it. He must be ready to start to fires at all times, day or night. He will never delay start in order to cook or eat a meal after he has orders to go.

He Must at All Times Keep:

Himself neat and appropriately dressed.
Twenty-four hours water supply on hand.
Two weeks wood supply—cut up—stove size.

Buildings and grounds in a neat and sanitary condition.
Fireman's pack complete and ready to go.
Horse ready to go in daytime (hours specified by ranger, otherwise 7 a.m. to 7 p.m.).
Car ready as specified in "General Instructions."
Phone working. (Proved by regular scheduled test calls.)
Available to phone call day or night unless absence authorized.
Watch checked with headquarters—correct time.
"Lookout Fire Report," Form 17 R-1, notebook and pencil near phone.

Lightning Strikes:

The fireman, if not located at a lookout point, will:

Take compass bearings on nearby lightning strikes.
Obtain distance by the method described in lookout instructions under "Recording Lightning Strikes."
Report them to ranger headquarters.
Locate strikes on map.
Search for lightning strikes when so directed.

Receiving Reports:

The procedure in reporting fires and receiving reports should follow uniform practices so that error in relaying location and failure to get complete information is less likely to occur.

When a fire is reported to the fireman and he is instructed to go to it, he shall proceed as follows:

Take all information indicated on such form as provided for this use. Always write down location and instructions.

Mark location on his field map and decide the best route to take. CHECK THIS DETAIL WITH DISPATCHER.

Determine compass back sight on lookout, check with dispatcher and enter with other notes on location of the fire and carry with him.

When the Fireman Discovers a Fire His Procedure Shall Be:

Fill out "Lookout Fire Report" as completely as possible.
Mark location and best route of travel on his map.
Telephone the information to ranger headquarters.
Ask for instructions.

If communication with ranger headquarters is impossible, call a neighboring station or, if no one can be reached by phone, leave a note telling location and when he left for fire.

When a fire is discovered from some point away from communication, if fireman can reach phone or radio and report without chancing escape of fire, he should do that. If fire is in dangerous condition and within his reach, he should leave note on trail or road where he leaves for fire, stating location of fire, time of day, date and route he takes.

If instructions as to preparedness have been followed, not over five minutes should elapse from the time the fireman receives the report until he starts for the fire. Get-away time in excess of this must be explained to the ranger.

Travel to Fire:

To delay starting to a fire on account of darkness invites defeat.
Start immediately whether day or night.
Travel continuously at night as well as day.
(Exceptions to these rules shall be taken only upon the specific approval of the man in charge of the district in each instance.)
Fill canteen at start of trip and refill en route if possible so that canteen is full on arrival.
Take quickest route to the fire location.
Travel by road or trail is often quicker, though the distance is greater.
Make frequent observations en route, using lookout trees, open slopes or points.
Use back sight reading on lookout point to get on line when possible.
If the fire is seen at any time pick an easily identified landmark near it.
Mark take-off point on trail, giving direction taken.

Extinguishing Small Fires:

The fireman must be familiar with and make use of the most effective methods and technique of stopping fires and putting them out. He must appreciate the necessity of stopping every fire as soon as possible and before 10 a.m. of the day following discovery. Many fires will be corralled long before that time. An explanation is required for each fire not corralled before 10 a.m. because it then becomes an extra-period fire, will be exposed to the danger period of the day, and may for that reason become a conflagration.

Experience, training and good judgment are invaluable assets in fire fighting. The following suggestions will not replace them but will serve to refresh the memory of the man who knows something about the job. Disregard of one or more of the points listed have been responsible for *many fires getting away.*

Upon Arrival at Fire:

Make note of the time, size of fire by dimensions, width and length. Place fireman's pack in a safe place.

In Sizing Up the Fire to Determine Points to Attack, and Methods to Use, Consider That:

Extreme heat is always dangerous and must be dealt with first.
It may cause fires to crown, throw spots or spread fast.
Fire travels faster uphill than down.
If slope is steep fire brands may roll downhill, starting more fires.
Fire high up in snags or trees may defeat efforts on the ground by throwing sparks.
Wind generally blows up slopes in daytime.
Wind fans a quiet fire into a dangerous one.
Fire is generally worst from 1 p.m. to 5 p.m. Danger increases 7 a.m. to 4 p.m. Decreases 7 p.m. to 7 a.m.
Ordinarily fires do not spread rapidly in duff.

Attack—Controlling Fire:

Cool hot spots with mineral soil. Use lots of dirt and reduce flames as first step.
Look outside the main fire for spot fires. If any are found, cool them down and make them safe.

Rob fire of top fuels to stop spread, scatter ignited fuels well back inside and throw unignited fuels outside.

Cut off points of fire burning toward bad fuel.

If fire is not too hot make your line directly at the edge; scrape and shovel the edge back into burned area.

If fire is too hot to work the edge, locate line where there is greatest assurance of *holding* it. Avoid sharp angles on slopes. Trench out snags, etc.

Shovel and scrape edge of fire into burned area.

Cool down hot fires under low branching trees inside the fire with dirt, to prevent crowning.

Fell all burning snags or trees that have fire too high to put out without felling, being careful to prevent fire from spreading when they fall.

On steep slopes cut a deep trench, or bank up duff and debris below fire and cover with mineral soil, to catch rolling embers.

Systematic well-directed action and steady pace are most effective.

Over-exertion does not pay.

For additional details see suppression sections in this Handbook.

Mop-Up—Putting Fire Out:

Trim off low tree branches, remove fuel from around trees and snags.
Turn logs or chunks on slopes, so they cannot roll.
Scatter burning fuel near edge back into burn.
Separate burning logs and spread rotten wood, duff and embers.
Dig out underground fire. Don't bury it.
Cut and scrape fire from logs, chunks, stumps, snags, trees, etc.
Throw mineral soil forcibly into burning cracks and weather checks.
Use dirt in the same way as water to put fire out.
Mix burning fuels with mineral soil, turn over, dig up and stir repeatedly.
If water is used soak all sides of fuel, turn over, feel for live fire and drench again.
Burying stump roots may carry fire under trench to outside fuels. Dig them up.
White, fluffy ashes indicate heat; feel them out.
Search nearby snags and tree tops for fire.
Look well outside fire line for spot fires.
Repeatedly look over, dig up and feel over burned area for smoke or hot spots.
Investigate stumps and roots for smouldering underground fire.
Feel around fire edge with bare fingers for hot spots.
See that there is an absolutely clean line cut to mineral soil around the entire edge of the fire and that nothing can roll across this line.
Before leaving spend sufficient time feeling and moving fuels to make absolutely sure the fire is out—*dead out.*

Returning From Fire:

A complete report on Form 592, Fireman's Report, must be made out *before leaving the fire.* A copy will be sent to the ranger at the first opportunity. Complete notes will be required covering reasons for any delay or difficulty experienced in finding or suppressing the fire. These should describe the methods used to overcome the difficulty.

Mark route from fire to intersection with trail or road.

Report to headquarters from first telephone reached.

THE PATROLMAN

Patrolmen are usually placed on account of special dangers, or to cover areas not within reach, or not adequately seen from any lookout.

Men will be selected because of their qualifications for the particular job and will receive definite, detailed instructions from the ranger. The ranger will also be responsible for training patrolmen on the job in the technique of meeting the public and educating them in care with fire, policing camp sites, law enforcement, etc.

The Patrolman Must Be:

Physically able to do hard work and hiking.
Clothed in guard's standard uniform if working in area heavily used by forest visitors.
Competent to keep essential reports and records.
Courteous and friendly in contacts with public.
Well informed and firm in enforcing fire laws and restrictions.
Qualified for lookout and fireman's work.
Trained in the details of the particular jobs assigned to him.
Acquainted with the area adjacent to his route.

The Patrolman Must Have:

His car or horse in condition as specified in "General Instructions."
Fireman's pack complete and in car or ready for horse transportation.
A portable phone in car ready for quick hook-up, where feasible.
Phone tested daily.
His watch checked with headquarters daily.
Proper forms for receiving reports and reporting fires.
Suitable hiking shoes and other field clothing in car and ready for quick change.

Duties:

Put up and take down fire posters according to ranger's plan.
Replace soiled, unsightly and damaged posters.
Contact local people and forest visitors at every opportunity as prescribed by ranger.
Observe and enforce special restrictions such as smoking rules, closures, etc.
Check on shovel, axe and bucket requirement.
Obtain compliance with camp rules and restrictions.
Keep a record of recreationists as specified by ranger.
Warn campers of fire danger.
Instruct campers and smokers in correct use of fire.
Inspect and police improved campgrounds and other camp sites as directed by the ranger.
Report unsatisfactory conditions at camps and the action taken.
Make scheduled stops and fire observations and report by telephone according to prearranged schedule.
Locate accurately with compass and map all fires observed inside or outside his area.
Make report on Form 17 R-1 and telephone it to headquarters.
Report and extinguish fires within his area.
Be ready to go to fires anywhere directed by ranger or dispatcher.

The patrolman shall be guided by the instructions under "The Fireman" pertaining to:

Lightning strikes.	Travel to fire.
Receiving reports.	Searching for fire.
Extinguishing fire.	Returning from fires.

Patrolmen used under circumstances to which these instructions do not apply in whole must be guided by special written instructions from the ranger and should make use of such parts of these instructions for fireman as are applicable to his job.

THE TRUCK DRIVER

Quick action in getting men to fires often is dependent on the readiness of equipment and efficiency of the men who drive the trucks. Delays due to failure of battery or ignition, gas shortage, poor tires, etc., may cause disastrous results. They are due to human failure and are inexcusable.

Every man (except CCC or ERA drivers) who drives a Government truck or car is required to have public liability insurance. The supervisor or ranger will advise where and how to obtain it. Only in emergencies such as a going fire may this requirement be dispensed with.

The Truck Driver Must Be:

Able-bodied and willing to work long hours in emergencies.
Capable of keeping essential records and making intelligent reports.
Of sufficient mechanical ability to make minor truck repairs and able to keep all parts of engine or truck working properly.
A careful driver and courteous to the public.
Able to make good time without taking undue risks.
Experienced or trained in the details of his job.
Able to handle trucking efficiently over rough mountain roads.
Familiar with all roads in the district, which can possibly be used by trucks.
Qualified through training and instructions to control and put out small fires.

Duties:

Truck equipment and supplies as district needs require.
Protect supplies and equipment from rain, theft, sun and dust in transit.
Do any miscellaneous hauling required.
Keep truck in working condition at all times.
Keep gasoline tank filled, brakes adjusted, battery filled and truck otherwise conditioned and equipped as specified in "General Instructions."
Have tire pressure card posted in truck and tires inflated as specified.
Service truck currently and keep up "Truck Service Reminder Card."
Post "Instructions to Truck Drivers" Form 118-R-1 in truck, read and comply with the instructions thereon.
Promptly replace worn, broken or lost parts and report trouble which requires a skilled mechanic.
Make minor repairs as needed.
Keep engine clean and wash truck frequently.
Fill out daily truck reports.
Keep a diary or daily record of orders and important occurrences.
Communicate frequently with ranger headquarters on all trips during fire season.
Provide truck with *safe* seats for hauling men.
Be prepared for immediate fire duty, day or night.

Get copies of waybills at time of loading and have them signed when load is delivered.

Know highway traffic regulations applying to territory in which he is assigned.

Pass a Government driver's examination and carry a driver's license at all times while operating a motor vehicle.

When Going to Fires He Shall:

Before leaving get location of fire and place to unload.

Know or find out best route to take.

Make note of name of man in charge at fire.

Find out most essential equipment to go on first load.

Make best time possible without taking undue chances.

If possible, phone ranger or headquarters when load is delivered.

Lose no time in returning for second load.

THE PACKER

The packer should understand and be chosen with the idea that he is an essential part of the fire control organization and that his responsibilities do not end with packing alone.

The Packer Must Be:

A man who understands and likes to handle stock.

Physically fit and willing to work long, irregular hours.

Able to understand and follow all instructions.

Capable of making accurate, essential packer's reports.

Thorough and fast in cargoing packs and in loading stock.

Qualified to do fireman's work.

Eager and willing to go through to fire day or night.

Willing to do other jobs assigned him.

Packer Must Know How and Be Expected to:

Handle stock quietly and effectively.

Never rope to catch stock, except as last resort.

Feed properly—economically.

Train green stock.

Give green or unruly stock sufficient work to keep them gentle.

Wrangle stock at daylight and in hot weather have them on the trail in time to take full advantage of cool morning travel.

Prepare loads and cargo packs the night before.

Weigh side packs, number and stack in individual loads.

Estimate weight carefully when scales not available.

Ask for waybill, have receiving person sign for goods received.

Return receipt to headquarters.

Pack anything transferable by pack animal.

Protect packed materials from damage or losses.

Always take the mail.

Do own cooking when necessary and keep clean camp.

Make his own way over rough, untraveled routes.

Repair minor damage to trails and telephone lines.

Report to headquarters important damage seen on lines or trails.

Keep daily record of trips, loads, animals used and other data called for by ranger.

Keep up daily diary, recording important data.

Special Care of Stock:

Keep shod up. Have shod every six weeks.
Save and use serviceable used shoes. Don't use shoes worn thin or sprung out of alignment.
Keep backs free from saddle sores.
Brush and/or curry backs before saddling.
Adjust saddle to animal. Avoid changes afterwards.
See that animal's number and name is on saddle.
Never tie lead rope to front animal's tail.
Use ¼-inch tail ropes attached to saddle tree.
Balance loads at start, check frequently, keep balanced.
Train stock to reasonably fast walk.
Refrain from trotting loaded animals, except in case of extreme emergency.
Water stock at every good opportunity while traveling.
Let cool off before watering when animals are hot.
Inspect stock for injuries at end of each trip. Shoes, etc.
Treat cuts, sprains and bruises immediately.
If sore back develops, find cause and remedy it.
Bathe tender backs with cool salt water. (Not cold nor hot.
Trim mules' manes and tails at least once each month.
Never heat an animal quickly if it has been on dry feed.
Do not *experiment* with ailing animals—when you cannot diagnose the case or have no approved remedy available call the ranger for instructions. He will specify treatment or call a veterinarian.
Many so-called home remedies are dangerous—avoid them.
Make sick animals as comfortable as possible. Always keep head and back uphill if on sloping ground.
Maintain even normal temperatures by blanketing.
Provide hay, straw, boughs, blankets or some other dry bed for the animal to lie upon.
Never drench through nostrils.
Use mechanical rather than medicinal remedies where possible—usually a rectal injection of warm water is more effective than the best of chemical purgatives.

Feeding Pack Stock:

Use green feed whenever possible, even though it means increased wrangling time, except in case of urgent fire needs.
Take stock to feed, do not turn out to make their own way.
When hay and grain are fed, avoid waste, make and use rack for hay and nose bags for grain. Never feed grain on the ground.
Frequent small feeds are preferable to a few larger feedings.
See that stock tied up over night have level ground to stand on, free of objects which prevent lying down.
See that salt is provided regularly at minimum rate of three pounds per animal per month fed in boxes or salt troughs.
Do not water or feed oats to animals until they are cooled off at end of trip. Water before feeding.
Use of conventional hobbles is preferable to picketing.

Care of Equipment:

Keep rigging and halters repaired currently.
Replace worn rope, straps and other parts before they fail.

Stack dry saddles, blankets and pads in order on dry spot, if available, and cover with canvas.
Keep "half-breeds" properly padded with dried, curled bear grass or hair.
Frequently clean blankets and pads of matted hair or caked dirt patches.
See that blankets are washed whenever necessary.
Keep pack equipment and supplies protected from porcupine, bear, rats, etc. Store grain to prevent damage by rodents.

Fire Requirements:

Keep stock in good condition for fire call throughout fire season.
Always report in to headquarters when passing a telephone on a trip during dangerous fire conditions as instructed by the ranger.
Be informed concerning forest fire laws and regulations, and *observe them.*
Have necessary axe, shovel and waterbucket.
Carry other fire equipment required.
Keep constant sharp lookout for fires.
Determine map location of fires seen.
Be a qualified fireman. (See fireman instructions.)
Put out small fires near route of travel.
Report to headquarters at first chance, any fires seen.
When packing to fires have the following information:
  A map showing the location of fire camp, best route to travel and point to leave road or trail.
  List of equipment most essential to pack first.
  Name of men in charge of fire camp.

THE FOREST CREW FOREMAN

The forest crew foreman must be able to:

Stand hardships and hard work.
Take care of himself and men under adverse conditions in the woods.
Use the compass skillfully.
Read a map in detail.
Find way through the forest with map and compass.
Set up camp in a convenient and workmanlike manner.
Organize and handle men on fire efficiently.
Instruct men in best methods of fire and improvement work.
Teach men to use tools properly.
Keep tools and equipment in A-1 shape.
Act as lookout or fireman when necessary.
Keep essential records accurately.
Make simple telephone repairs.
Understand and follow written instructions.
Keep a wholesome crew spirit.
Hold the respect of the men under him.
Maintain discipline in crew.

Organization:

The improvement foreman may have charge of a crew on trail, road, tower house construction or other forest improvements. Regardless of the size of his crew or nature of his assignment, his responsibility is the same for the action of his crew in being prepared for, going to and suppressing forest fires.

The crew will be trained as an overhead unit composed of firemen, foreman, cook, timekeeper, subforeman, straw boss, camp boss, saw crews, etc., depending on the number of men in the crew. Thus his crew may be used to overhead a crew of hired firefighters; it may be used as a unit on small fires or men may be drawn from it for smoke-chasing and other specific fire jobs.

Early in the season the crew will be organized and trained in fire action, an organization plan made and an outline of action and specific instructions issued.

The foreman must be familiar with the plan and test his crew as to their ability to carry it out. He must also understand the different methods of fire fighting and be able to handle men efficiently both by the squad method and by assignment of a section of line to each man. (See fire suppression chapter of this Handbook.)

Foreman and crew in whole or in part must be prepared to take quick action on fires anywhere they are directed to go by the ranger or dispatcher.

The Foreman Must Have:

Communication working. (Proven by daily test.)
Some man or men in crew trained and designated as "Crew Firemen."
Fireman packs and crew packs complete, hung up under shelter and ready for use.
Tags on all packs showing contents and checked with contents of pack.
Fire equipment outfit and plow, trencher or pump unit if so equipped, ready for quick get-away.
"Fire Report" blank Form 592, or other approved form, near telephone or radio, for receiving and reporting information on fires.
Drivers or driver instructed and familiar with their duties if trucks used.
Trucks in shape as required under "General Instructions."
Crew or part of crew held in camp during dangerous fire weather, when directed by ranger or person in charge of district.
Shoes and other personal equipment of crew members in shape for cross-country travel and service on fires.
Provision, if practicable, for fire calls out on the job. Prearranged system for loading men and equipment.
Prepared lunch ready to facilitate quick feeding en route or at the fire.

Fighting Fire:

On large fires the plan of action will have been mapped out by the fire boss, and the foreman instructed generally in writing as to his part of the job. On smaller crew fires the foreman may be in charge of the fire unless relieved by the ranger or his alternate.

The Following Practices Are Important:

Make use of rules under instructions to firemen, under "Extinguishing Small Fires."
For larger fires see fire suppression chapter of this Handbook.
Use every opportunity to instruct men in firefighting methods, use of tools, safety, proper care with tools, etc.
Correct faulty or useless work at once.
Someone must stay with every fire until it is out—dead out.
See that a reliable man is assigned.

Report:

If a fireman is replaced by a foreman and his crew, he must fill out his part of the fireman's report and give it to the foreman, who is responsible for completing the report.

Forms 592 are in all fire packs and must be filled out before leaving the fire.

An accurate time record must be kept for all men and this accounted for as between firefighting and the regular job on which the crew may be engaged.

Keep detailed notes covering any delays or difficulties experienced and reasons for any lost line or "blow-ups."

Action During Lightning Storms:

Get in touch with ranger headquarters at once and act according to special instructions when a lightning storm is approaching. See that all preparations for going to fires are complete. Have all members of crew watch for strikes and smokes. After the storm, if so directed by the ranger, patrol to pick up possible fires.

Travel to Fires:

Before leaving for a fire:

- Get all the information indicated on the margin of "Lookout Fire Report" Form 17 R-1, or other form provided, and check with dispatcher.
- Determine method and best route of travel.
- Ascertain from the ranger the part the crew will take in the organization on the fire.
- Figure the back sight reading on lookout, record in notebook and check with dispatcher.
- When sending firemen to fire, see that they have complete information on the fire and route to travel and are completely equipped.
- Provide marked line from best point on trail for take-off across country to the fire.
- Keep men together while traveling.
- Men may carry backpack tools and equipment if not on road.
- Use smoke-chaser tactics for searching out a fire. (See Instructions for Fireman.)

THE PER DIEM GUARD

The best qualified men are selected from communities within or adjacent to the forest and appointed annually as per diem guards. They must be men who are interested in fire control work and willing to cooperate in the detection and suppression of fires within their own or adjacent neighborhood. It is also desired, so far as possible, they be available as smoke-chasers, straw bosses of foremen in case of real need at other points.

Due to the special nature of the job assigned a per diem guard, the ranger shall furnish him special *written instructions* or memorandum of agreement annually which will supplement the following general qualifications and statement of responsibilities.

The Per Diem Guard Should Be:

- A leader in his community.
- Experienced and trained in fire control work.
- Thoroughly familiar with his territory.
- Willing to work long hours on fire.

Ready to take action on fire, day or night.
Physically fit and capable of backpacking across country, day or night.
Able to use compass, and to read a map correctly.
Trained in proper methods of firefighting.
Capable of recruiting and leading small fire crews.
Loyal to the principles of forest fire control.
Familiar with the district communication system and fire reporting procedure.
Prepared with necessary map, fire forms, general and special instructions with which he should become familiar.
Informed on forest fire laws and regulations.

The Per Diem Guard Will Be Expected to:

Check up with ranger on action of each fire discovered by or reported to him.
Watch and report on action of lightning storm.
Make scheduled telephone test calls as outlined by ranger.
Go to and extinguish fires as directed by ranger.
In case ranger cannot be reached, take such fire action as seems necessary.
Be willing to adjust home work to meet fire needs.
Make necessary agreement with several dependable men who can assist on fire work as agreed upon with ranger.
Comply with instructions to firemen when going to and suppressing fires.
Make fireman's report Form 592 for each fire before leaving it.
Report to ranger promptly upon return from a fire, giving time for himself and men, etc.
Report promptly to ranger on fire law violations, giving evidence obtained by him.

The Per Diem Guard Shall Be:

Furnished with fireman pack of standard in use on forest concerned.
Supplied with such crew equipment and rations as conditions require.
Responsible for keeping such equipment in readiness for fire use, except when a forest officer is responsible.
Authorized and required to see that equipment is not used except for fire.

COOPERATORS

Within and adjacent to the national forests, many people contribute to fire control by assisting in detection and suppression of fires whenever possible. These cooperators are a valuable part of our fire organization, and every forest officer and guard is responsible for cultivating and promoting this cooperation.

Cooperators are grouped in two classes as follows:

Forest Permittees:

Those bound by stipulations in their permit or contract to assist in fire control work. This cooperation by permittees is a part of their payment for special privileges such as grazing, timber sales, rights-of-way, construction projects, etc. An example of such agreement is included in all grazing permits as follows:

"I bind myself and my employees, while on or in the vicinity of the national forest, to extinguish all fires started by me or them. I will do all in my power individually and voluntarily to prevent and suppress fires on my range allotment or in its vicinity and will report promptly to the local officers all fires that I or my employees may discover which we cannot suppress through our own efforts. Unless prevented by circumstances over which I have no control, I will place myself, my

employees, and my transportation facilities at the disposal of any authorized forest officer for fighting fires. Payment for such services shall be at the current rates of pay prevailing within the said national forest for similar services. If, however, I or my employees are directly or indirectly responsible for the origin of the fire, no payment shall be made for the services so rendered."

Forest officers, guards and others responsible for fire control should familiarize themselves with the fire requirements in contracts of all permittees in their territory and reach a definite understanding as to what each will be expected to do in case of fire.

Other Cooperators:

Includes all persons who are in position to assist in fire detection and suppression, but who are not required by formal contract to do so. In other words, this is the free cooperation which results from willingness of people to assist in community and national welfare. It is this valuable cooperation that forest employees can obtain through their own efforts.

SUPPRESSION OF FIRES

Firefighting is the final test of the protection organization. Success is contingent upon the degree of preparedness, leadership and aggressive application of the best-known methods and technique of fire suppression. The problems involved in suppression of fires vary to such a great extent that it is impracticable to attempt discussion of all situations which may occur. An attempt is made to cover a cross section of situations by which the more important principles of firefighting are illustrated. Likewise, approved tactics and techniques are explained individually, and it is assumed that the fireman will apply whichever method or combination of methods may be necessary to effect most sure and speedy control.

To the uninformed, fire is more or less a thing of mystery. To the fireman it is a simple chemical process similar in many ways to the oxidization of iron commonly called rusting. Fire is a chemical action called combustion, accompanied by light and heat. In order that combustion may take place in the forest, there must be a fuel composed largely of carbon and hydrogen, which when heated to the kindling temperature, will combine with oxygen from the air and result in combustion (fire).

Once fire is started there are but three known methods for stopping it. Remove the fuel, thus starving the fire; shut off the supply of oxygen; prevent fuels from being heated to kindling temperatures. In firefighting we clear fire lines of fuel to starve the fire; we shut off its supply of oxygen by smothering it with dirt or water; we prevent heating of fuel to kindling point by removing it or by cooling it with water.

Knowledge of those factors which influence the spread of fire is necessary to accuracy in sizing up a suppression job and selection of proper tactics. The following paragraphs briefly describe some of the most important of these influences.

FIRE BEHAVIOR

A combination of all the factors, elements and influences which determine fire behavior is known as fire danger. These are: fuels, weather and topography. Success in fire suppression is dependent upon the fireman's ability to identify these factors and his knowledge of the part each plays in fire behavior. All must be considered in their true and relative importance for each fire problem.

FUEL INFLUENCE IN FIRE BEHAVIOR

There are several elements which influence the combustibility of fuels and the rate with which fires spread under similar topographic conditions. These are:

Moisture Content:

Fire igniting a piece of fuel must dry the wood before it actually catches fire. The less water in the stick, the shorter this period of drying and consequently the faster the fire spreads.

Size or Character of Fuel:

Fine sticks or particles of fuel are more quickly dried out and heated to the point of combustion than are larger pieces. Hence, fine fuels cause faster spread. This holds true when other conditions are equal. However, when fine fuels become so compact that air is not permitted free circulation, these lighter fuels burn slowly. Packed duff, sawdust, etc., are examples. Grass, fluffy needles and loose piles of brush are examples of fast spread types.

Volume:

The quantity or volume of fuel on an area is one of the most obvious factors of probable fire behavior and is seldom overlooked. It is helpful, however, to notice carefully whether the volume (cubic feet per acre) is composed of fine material, large sizes or both.

The greater the percentage of fine material the faster it will change in inflammability during the day and night and the flashier it will be. Large sized material will change slower, will burn longer and will require more work before mop-up is completed. A mixture of both fine and large fuels is by far the most dangerous. Fuel volume coupled with fuel size and character often determines the method of attack and size of the job. Observations and considerations must be carefully made.

Continuity and Arrangement:

Given a certain volume of fuel there are still features of arrangement or position which influences spread of fire as well as difficutly of control. If these fuels are all on the ground and spread out evenly the fire will spread fast and in all directions. If these same fuels are patchy, broken up by areas of thinner fuels, skid roads, rocky or barren spots, the spread will be sporadic and control probably easier. If these same fuels are partly on the ground and partly in the air—standing snags—spread may be slower and heat less intense but spotting may occur and with severe wind this may cause the most difficult fire. Continuity and arrangement of fuels is sometimes more important than volume and each case calls for different tactics. It pays to look carefully at these conditions in sizing up a fire.

WEATHER INFLUENCES

The two major features of fire danger that vary from day to day, and by hour of the day at any one place are (1) fuel moisture and (2) wind velocity and direction.

Fuel Moisture:

This has been discussed in preceding paragraphs. It is measured in computing danger ratings and the daily trends in variation are generally known. It is also known that fuels are drier on areas exposed to sun and wind than on timbered and north slopes.

Woody fuels seldom dry out to less than 3 per cent moisture content in this Region. Less than 5 per cent is an indicator of critical conditions even when other elements are not severe.

Wind:

Wind is the most difficult factor to predict. General trends of seasonal and hourly velocities are indicated on charts on following pages.

The data on these charts are averages and must not be accepted as predictions. They serve only to show relative trends. However, firemen must know the normal and the forecasted wind conditions for the area in which his fire is burning. To this he must add what he can reasonably anticipate as the worst probable. He must recognize that due to highly localized conditions, wind velocity may be far greater than indicated by general forecasts. He must identify topographic features which obviously affect wind direction and velocity. He must give full consideration to daily shifts in wind direction, up and down canyon drifts, etc.

Normally wind currents are up canyon during the day. At night, if the canyon is steep and not exposed to prevailing wind, the current will likely be down canyon.

Large fires on steep slopes often generate enough heat to upset the normal down-valley winds at night. Any fire of more than six or eight hundred acres may be expected to create considerable wind of its own, the direction and velocity being influenced by local topography and the amount of heat generated by and rising from the fire.

Winds affect a fire in five ways:

1. They increase combustion by augmenting normal supply of oxygen.
2. They tend to drive the flames and heated air out of its natural upward course into a more or less lateral or oblique direction, which naturally expedites combustion and spread in one direction by bringing them closer to surface materials on the lee side of the fire and farther from them on the windward side.
3. They carry sparks and burning embers either into or ahead of the fire.
4. They increase evaporation by carrying away the air which has been absorbing moisture by contact with damp surfaces and bringing in new supply.
5. They may result in greatly lowering or increasing the relative humidity of a locality, depending on whether they come from an arid or damp region.

To improve your ability to estimate wind velocities, when instruments are not available, study the "Northern Rocky Mountain Scale of Wind Velocity" chart included in the weather glossary of this book.

Humidity:

Moisture in the air greatly influences the behavior of fire. It is expressed in terms of the per cent to which the atmosphere is saturated. At 100 per cent the air contains all the moisture it can hold and water begins to settle to the ground.

Humidity affects quick changes in the moisture of fine fuels such as grass, needles and particularly moss. Its effect in heavy fuels is much slower. The amount of water in the air drawn into the fire materially affects the intensity of burning. On foggy days fires burn slowly due to the humidity. On cloudy days the effect of humidity is noticed. Likewise, it is the increase in humidity which causes fires to slow down during the night.

Humidity has a direct relation to fuel moisture and while not as dependable as fuel moisture measurements and ratings, may be used to advantage when the latter are not obtainable in determining probable fire spread.

Concerning fine fuels only, humidity may cause the following variation in fire behavior (without wind).

From 0 to 30% . .	High to extreme inflammability.
From 31 to 50% . .	Moderately inflammable—will catch fire readily and gain headway.
From 51 and over . .	Fires smolder and spread is slow.

TOPOGRAPHIC INFLUENCES

Topography influences fire behavior in many ways. Perhaps most important is slope, which tends to increase spread in the following ways:

1. On steep slopes the unignited fuels above the fire are closer to the flame, become heated and catch fire more quickly than if on level ground.
2. Wind currents are normally uphill and this tends to push heat and flame against the ground and new fuels.
3. Slope causes burning embers to slide and roll down hill into new fuels and thereby increases spread.

Other topographic influences, more important on large than on small fires, include:

Breaks in Topography:

Ridge tops and canyons cause changes in air currents. Those lying across the front of a fire tend to slow up spread. Smooth, long sustained slopes permit fire to gain momentum. Rugged topography causes extreme exposure to wind and sun of those fuels on south and west slopes. Likewise, it affords shade and cooler temperatures on east and north slopes.

Topography is an important factor in considering tactics to be applied.

DANGER RATINGS

Considerable confusion and some errors in estimating fire behavior have occurred in R-1 during the past few years due to failure to understand the R-1 danger ratings. It should be clearly understood that the danger class as posted on the standard danger chart, and as reported daily to Missoula, is a total danger or organization index and NOT a fire behavior index. It is a guide to intensity of district organization needed but not to probable behavior of a given fire. The latter must be calculated on best information available as to exact conditions at the site.

Fuel moisture, wind, lightning storms and visibility distance all affect the number of men needed currently for adequate fire control on a ranger district. All of these factors, season of year, humidity and debris burning season are considered when the danger meter is used to determine the standard danger class. This danger index is intended solely as a guide for determining the size of the fire control organization warranted by current conditions.

To provide a rough index of fire behavior to be expected in any particular fuel type on any particular class of day instructions are printed on slide B of the danger meter. The indicators obtained by this method are not sufficiently refined or accurate for use in dispatching; they merely show the general changes of rate of spread to

be expected in each standard rate-of-spread type as the danger class changes. This is an important phase of our fuel type and danger measuring systems and it is included inside the danger meter merely to explain the general relationship between danger class and fuel type. A large amount of research and further experience will be required before a dependable fire behavior meter can be produced for use in our complex and varied fuel types.

THERMAL BELT

One topographic condition heretofore generally overlooked in fire suppression is the existence of an altitudinal belt, part way between the valley bottom and the mountain top, in which fire behavior for the day and night can be expected to be worse than either the valley bottoms or the mountain tops. This zone or belt is called the thermal belt because temperature conditions caused by mountains produce it.

This belt has been found to begin about 600 or 700 feet above the valley bottom and to end about half way to the mountain top. In elevation, the thermal belt lies at approximately the mid-point between valley bottom and mountain top.

In this zone during fair weather of July and August, daytime temperatures are about as high and humidities as low as in the valley bottom. At night, however, from about 1 p.m. to 6 a.m., temperatures are materially higher and humidity (and therefore fuel moisture) are materially lower than at either the valley bottom or the mountain top.

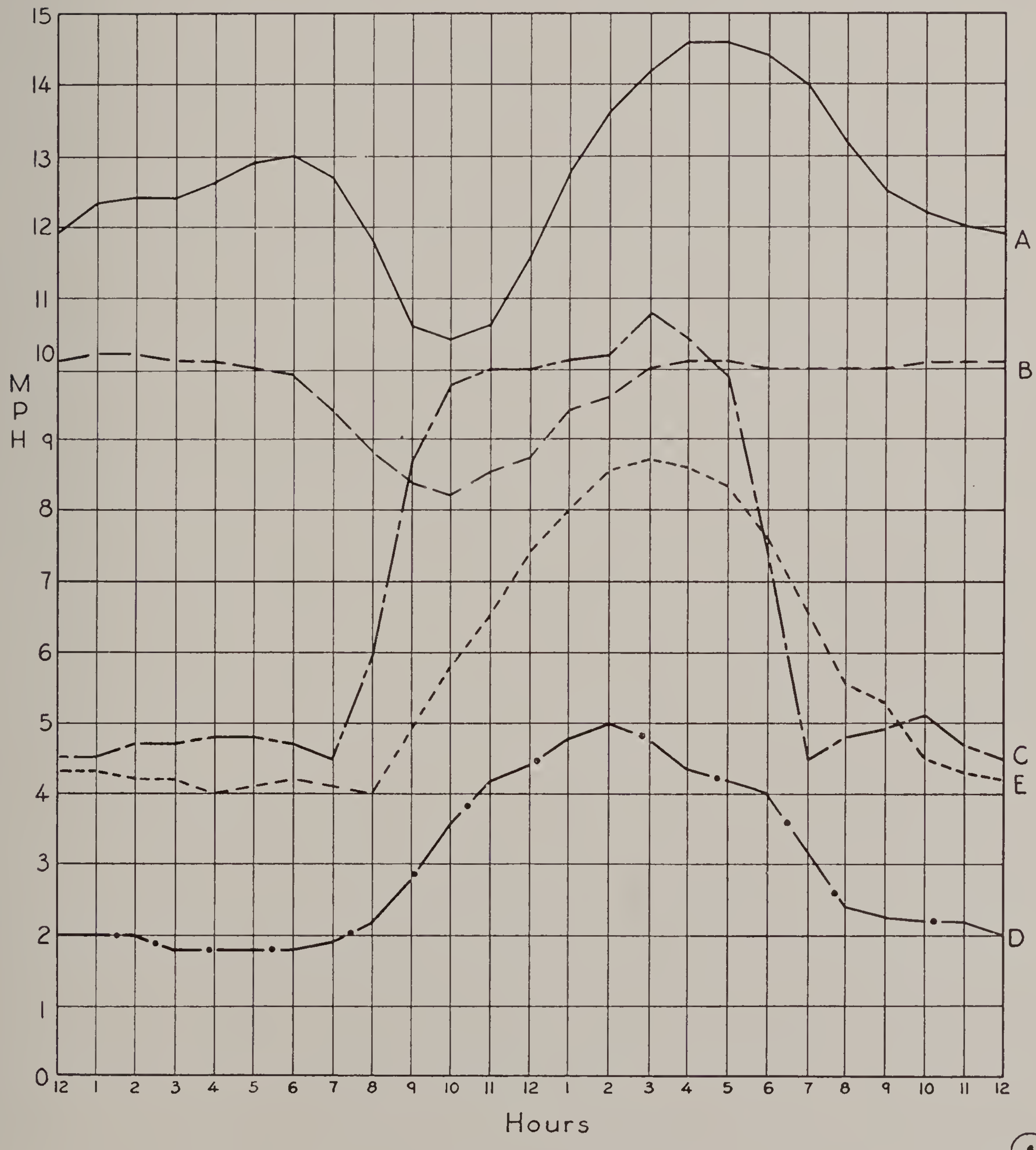
These conditions naturally result in more sustained high rate of spread in this belt and call for faster and stronger attack at night than would be required on other sites. As fires originating in this belt have the upper slopes ahead of them up which to run, and as wind velocity is almost always the greatest at the higher elevations, this thermal belt clearly deserves specific attention and special action by dispatchers and firegoers.

AVERAGE WIND VELOCITY

AUGUST

MOUNTAIN TIME

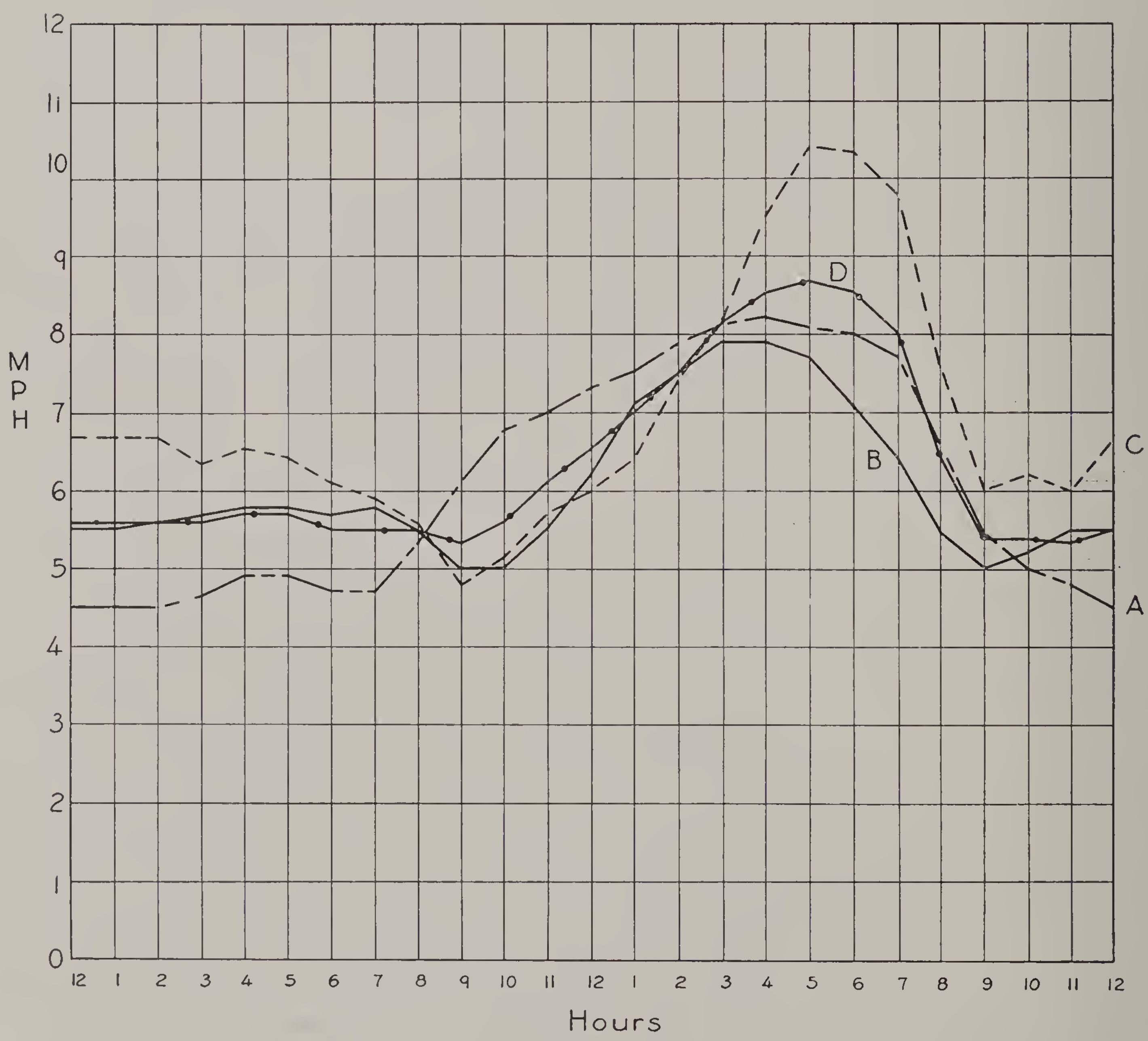
A — Exposed Peaks
B — Low or Sheltered Peaks
C — Exposed Valley Points (Narrow Valley)
D — Sheltered Valley Points (Narrow Valley)
E — Broad Valley



1

AVERAGE HOURLY WIND VELOCITY
AUGUST
MOUNTAIN TIME

A — WBO - Spokane
B — WBO — Kalispell
C — WBO — Missoula
D — WBO — Composite A, B, & C



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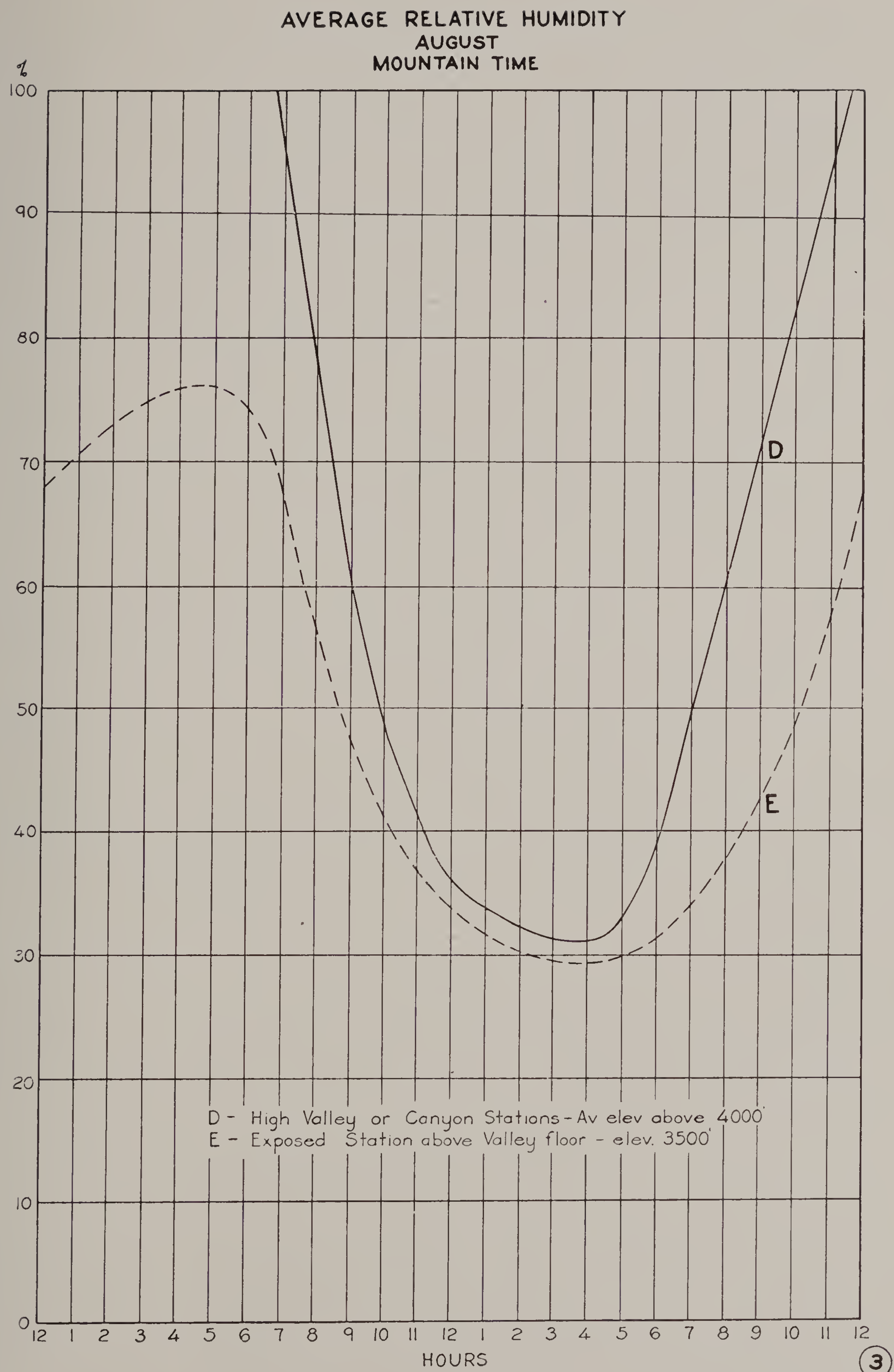
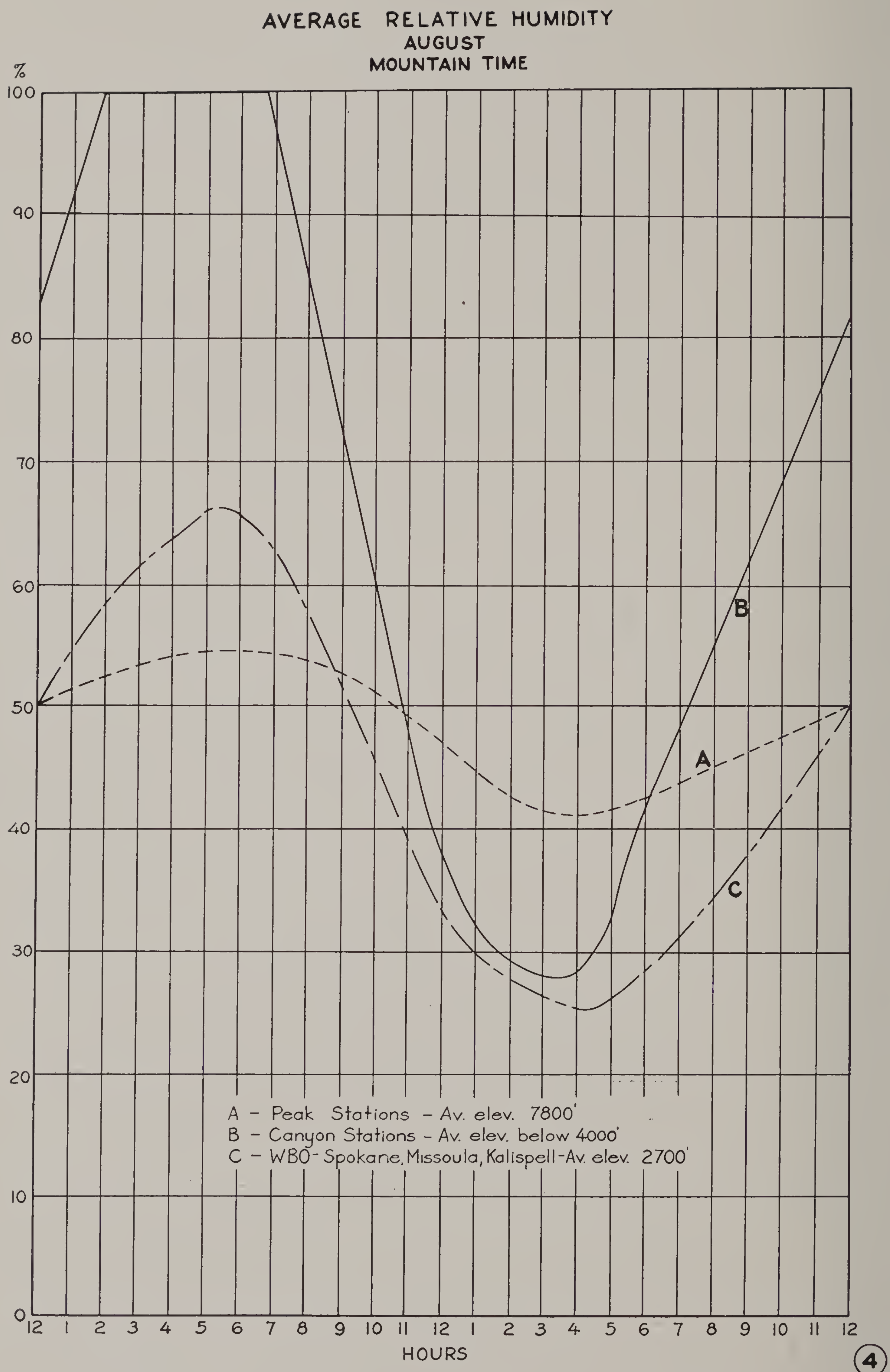


AVERAGE RELATIVE HUMIDITY
AUGUST
MOUNTAIN TIME
%
100
90
80
70
60
50
40
30
20
10
0
12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
HOURS
D
E
D - High Valley or Canyon Stations - Av elev above 4000'
E - Exposed Station above Valley floor - elev. 3500'
3


AVERAGE RELATIVE HUMIDITY
AUGUST
MOUNTAIN TIME
%
100
90
80
70
60
50
40
30
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12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
HOURS
A
B
C
A – Peak Stations – Av. elev. 7800'
B – Canyon Stations – Av. elev. below 4000'
C – WBO - Spokane, Missoula, Kalispell - Av. elev. 2700'
4

PROBLEMS AND PRACTICES

Suppression of small fires meets the same kind of problems and uses the same kind of practices as larger fires. Most effective handling of small fires involves successive steps, each with its own problems. This book is concerned with outlining these steps, illustrating by means of problems.

The following examples of situations or "problems," as they will be titled, are included for the purpose of:

(a) Depicting the problems which a fireman commonly meets in suppression of small fires. Each problem covers one simple, readily-identified situation.
(b) Indicating the action required to solve each problem.
(c) Stating why the solution is correct.
(d) Indicating when the same solution applies to other conditions than those outlined in the problem.

Study of these problems should help the fireman to establish the habit of first looking at the fire as a whole; second, analyzing it into parts; and third, deciding on and using methods of proven worth in meeting each element in the job.

Some of the sketches used to illustrate problems in this chapter will picture large fires. This should not confuse the reader if he will keep in mind that the point emphasized by the sketch is equally applicable on large and small fires.

To a trained and qualified fireman, suppression of a fire is not an exciting emergency. It is merely doing a job which requires knowledge of techniques, good judgment and quick but sound planning and aggressive action.

SIZING UP THE FIRE

This is the first problem met. Specific things to do include:

1. Go around the fire or see directly the entire edge.
2. Size up quickly the effect on present and future burning conditions. Observe:
   (a) Fuel burning adjacent to fire edge, particularly snags and logs, dead wood, brush, moss-covered trees, etc.
   (b) Fuel in immediate path of fire.
   (c) Topography (general).
   (d) Slope.
   (e) Wind.
3. Identify sections where fire is most likely to spread quickly into worse fuel.
4. Look for spot fires and if found, decide if they need action first.
5. Decide which is the most vital point of attack and begin work.
6. During size-up and controlling, decide if fire is man-caused; if so, look for and preserve evidence so far as this can be done without risking escape of the fire.

POINT OF FIRST ATTACK

After a quick size-up of conditions within the fire and in the surrounding country toward which the fire is spreading, the basis for action is laid.

What to Do in First Attack on Every Fire:

The universal rules are:

1. On basis of observations select key point of first attack where action will have greatest final effect in reducing spread of fire, and start action.

2. Stay with the fire; depend on follow-up; send a messenger only if help does not arrive within reasonable time.
3. Continue work day or night.
4. Revise plan of attack if necessary to meet changing conditions.

PROBLEMS (EXAMPLES) IN SUPPRESSION OF SMALL FIRES

Except as specified for individual problems, the following conditions are assumed for all problems in First Attack, Line Location, etc.

1. Attacking force consists of one man or small crew.
2. Suitable hand tools and back-pack pumps needed are available, but not tank trucks, horse and plow, trailbuilders or trenchers.
3. Normally bad, mid-season fire conditions exist. Logs, snags, etc., ignite easily and burn readily. Assume Class 5 fire danger.
4. Time of day: noon to mid-afternoon.
5. Dirt readily obtainable, except when otherwise specified.

Problem 1

Small Hot Fire Burning in Heavy Fuel (Slash, Dry Brush, Logs, etc.):

Action Required:

Throw dirt on flaming fuel (usually at base) to cool fire and shut off oxygen, then encircle with line at edge of fire.

5

Why:

Permits control of fire with minimum amount of line and with maximum speed. Minimizes danger of spot fires and does away with necessity for burning out line. Direct attack best.

Supplemental:

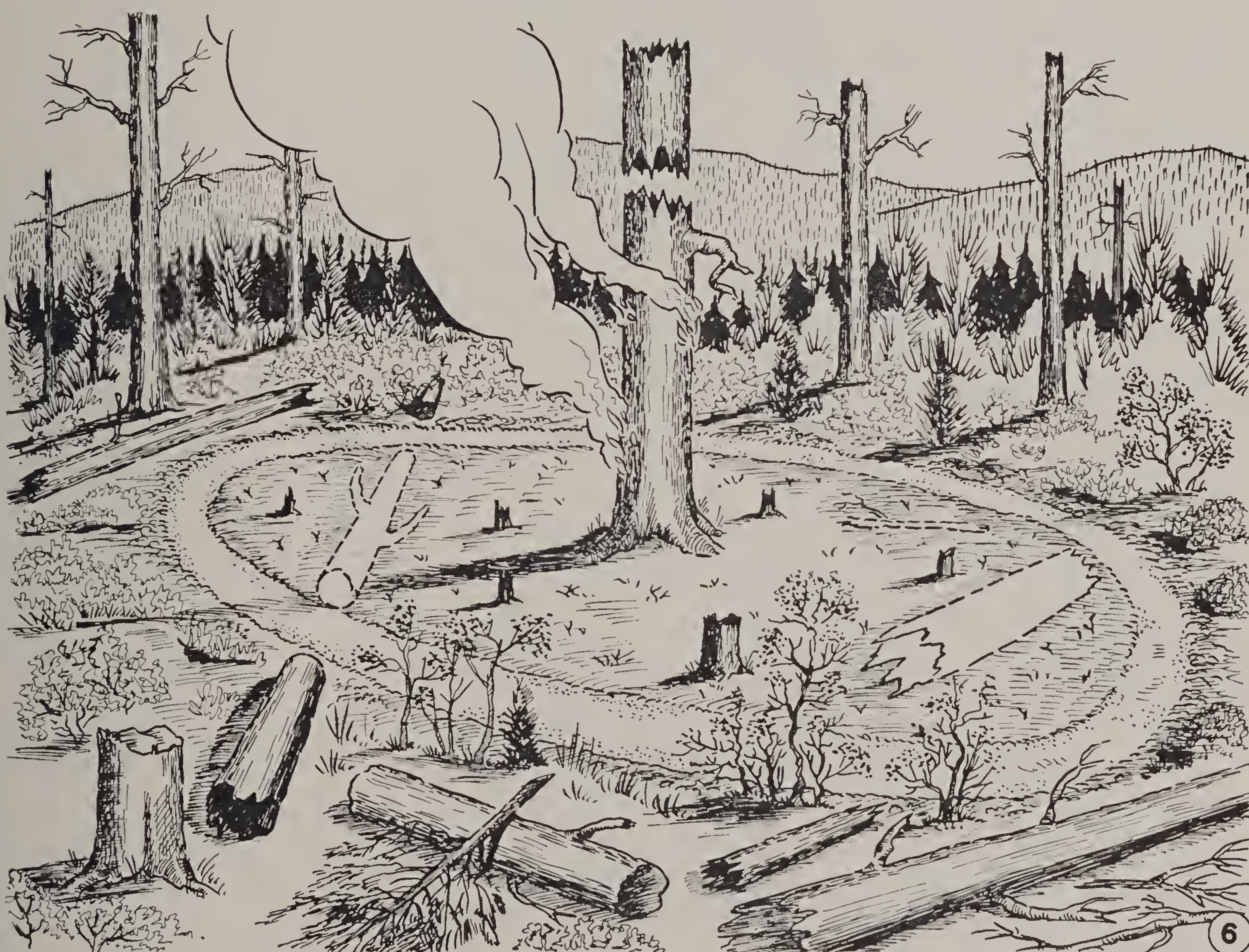
Water is often more effective than dirt. In light fuel, fires may be beaten down with a pine bough or other flail. Dirt is most effective when applied rapidly. If it is difficult to obtain, build up a small pile and then apply rapidly with a whipping motion. The beating or striking action, added to the smothering effect, increases the value of each shovelful.

PROBLEM 2

Fire in Base of Snag, Not Thoroughly Established:

Action Required:

Extinguish fire promptly in snag by use of dirt or water supplemented by scraping or chopping out burning material with shovel or axe and mixing embers with dirt to completely extinguish.



Why:

To prevent fire from enveloping snag and showering sparks into unburned area, thus causing spot fires, or increasing area necessary to include within line.

Supplemental:

The same solution applies to down logs in which fire is just getting a start.

Problem 3

Fire Established in Snag Above Base:

Condition:

Fire too high to reach with dirt. No water available. Continuous fuel all around snag. Light wind. Fire in snag burning briskly; too hot or too dangerous to fall snag. Level ground.

Action Required:

Keep watch for spot fires. Meanwhile remove fuel from around snag (including cutting and removal of brush or reproduction) for a radius sufficient to catch falling limbs or chunks. Then drop back to edge of cleaned up area and build fire line to prevent escape of any fire which may be started by falling embers. This line should be located to include the area in which the snag is likely to fall. This can be determined by the "lean" of the snag, the side on which it is burning most rapidly and the direction of wind. Unless snag burns down by the time line is completed, the fireman will cut it down. Even though it will burn off, the remaining snag or high stump will have to be felled and worked out before the job is completed.

Why:

To prevent falling burning material or the falling snag from spreading fire to surrounding area and to prevent spot fires.

Supplemental:

Same problem exists if there is wind or snag stands on a slope. Clearing and burning inside line would then extend further from base of snag.

PROBLEM 4

Fire in Top of Snag:

Refer to sketch No. 7 for Problem.

Condition:

Fuel in moderate quantity surrounding snag. Light wind. Snag burning in top; snag can be felled. Gentle slope.

Action Required:

Remove fuel which might permit rapid spread of fire from area large enough to catch snag, and then fall the snag and extinguish all fire in it by chopping out or with water or dirt. If ground so steep that snag will slide if felled downhill, it may be possible to drop it across the slope and cause it to lodge behind other trees or stumps which will hold it where it falls. If slope not too steep and stump is green, some trees may be felled uphill and the uncut part of the stump will hold the tree where it falls, and thus prevent sliding. Trench built on lower side of area into which snag will be felled should be deep and lower shoulder should be banked high to prevent embers from rolling across line when showered upon the ground by the snag's fall. Have dirt or water ready to knock down flare-ups which may occur when snag falls.

Why:

To get fire on ground where it can be extinguished, and to prevent spot fires. Direction felled will determine amount of area likely to be set on fire by snag's fall.

Supplemental:

Similar action should be taken with spike-top tree or green trees.

PROBLEM 4 (a)

Fire High Up in Snag Similar to Problem 4:

Refer to sketch No. 7 for problem.

Condition:

Heavy fuels surrounding snag. Steep ground, wind 12 miles per hour with strong gusts uphill. Snag 30 inches d.b.h. burning hotly 40 feet above ground.

Action Required:

Stop spot fires and get snag down to prevent additional spots. If several spot fires already started, stop most dangerous ones first. If no choice from standpoint of danger, control those farthest uphill first, and they will then serve as barriers against those coming from below. If spots are too numerous to permit treatment as individual fires, encircle group or groups of them with fire line and burn out intervening fuels. Locate and build line below snag to catch rolling embers. Fell snag at earliest moment possible into area prepared as in Problem 3. The job may appear hopeless, but a lull in the wind may occur at any time, and such a break may mean control if the job is well planned and hot spots checked.

Why:

First to prevent spot fires from spreading to other heavy fuels and snags, and thereby enlarging job. Second to fall snag and thereby eliminate source of trouble.

PROBLEM 5

Correct Use of Water in First Attack:

Condition:

Slope, cover, spread, etc., uniform. Spring or stream close by and back-pack pump available. Hot, fast spreading fire.

Action Required:

Use water to check fire on edge of burn; follow immediately with clean line to mineral soil through duff, decayed wood, etc.

Why:

Water stops spread of fire quickly, but usually fails to extinguish fire and in most types sudden breakouts are to be expected unless held in check by a fire line.

Supplemental:

Only in light grass cover can water be expected to do entire suppression job.

PROBLEM 6

Fire Spreading, About to Ignite Single Snag:

8

Condition:

Uniform fuel over area.

Action Required:

Control edge of fire nearest snag first.

Why:

To prevent fire from getting into snag.

Supplemental:

Same solution applies where fire is spreading and about to ignite logs, dense brush, reproduction thicket or slash.

Problem 7

Fire About to Crown in Reproduction or Brush:

Action Required:

Throw dirt at base of fire to cut down heat and prevent crowning, even if burning material is well within planned control line.

Why:

To reduce spot fire danger, rate of spread and possible loss of line.

Supplemental:

Same effect can be obtained by use of water.

Problem 8

Fire on Both Sides of Ravine, One Head Markedly Larger Than the Other:

9

Condition:

Uniform conditions of fuel, slope and spread.

Action Required:

Control smaller head of fire first; then start control of other head. If one side obviously in more dangerous fuel, stop it first.

Why:

To hold fire to one side of ravine, or to hold fire to least dangerous side.

Supplemental:

The same solution applies to cases where separate fires are burning on each side of ravine, or where a single fire is just reaching or threatening to cross, or where fire is burning on both sides of a road or similar barrier.

Problem 9

Fire Nearing Crest of Ridge—Danger of Rolling Material Carrying Fire Down on Other Side Is Imminent:

Condition:

Uniform fuel spread, etc. Topography steep. Pine cones and other fuels capable of carrying fire by rolling.

Action Required:

Attack first at crest.

Why:

To prevent ignition of fuel which would roll into unburned area, and hold fire to one slope.

Problem 10

Burning Log Lying Along the Contour of the Slope:

Refer to sketch No. 49.

Condition:

Steep country, good soil. Water not available.

Action Required:

Turn log around to lie up and down hill, roll it into prepared trench. If log is then too hot, cool it down temporarily with dirt. Let it burn out while action continues on remainder of fire. Do not bury log. May be put out later during mop-up by rubbing with dirt, scraping fire off, etc.

Why:

To prevent the rolling of burning material down the slope and excessive production of sparks. It is impossible with reasonable effort to bury large logs deep enough to smother out the fire. Buried logs burn through dirt covering later and are likely to spark out and cause spots over the line after they are left as out.

Supplemental:

If log is too heavy or too rotten to handle, dig deep trench below it, or block it up solidly with rocks, green chunks of wood or earth.

Line Around Fire but Unburned Material Between Line and Ragged Edge of Fire:

Action Required:

Burn out the material if fairly light fuels, preferably by burning back from the fire line. If heavy, slow-burning fuels, work inside line and put fire out with dirt or water.

Why:

To remove the danger of the fire flaring or spotting across line.

Supplemental:

A fire is never controlled until burned back from the fire line clean or until all fire inside is completely extinguished. Care must be exercised in clean-up firing on steep slopes or in wind. Burn down from top side. If danger of spotting, don't burn. Go inside and put fire out with dirt or water. When clean burning is impracticable, as it is sometimes in brush types, fuel should be cut and removed before leaving fire.

PROBLEM 12

Lower Edge of Fire Lying Along the Contour of a Steep Slope:

Refer to sketch No. 28.

Condition:

Considerable material that rolls readily, such as pine cones, chunks of rotten wood, etc.

Action Required:

Construct a deep trench well banked with earth on its lower side along the entire undercut portion of the line on which rolling material can be anticipated.

Why:

To catch and prevent the rolling of burning material across the control line into unburned territory.

Problem 13

Rapidly Spreading Fire in Needles, Grass or Other Fine Fuels:

Action Required:

Use scratch line only to make first check of fire, completing line after rapid spread is stopped.

Why:

To permit control of fire when building of safe final line in one operation cannot keep pace with spread.

Supplemental:

Same result can often be obtained by covering advancing edge of fire with dirt, or by use of water. In all cases it is necessary, finally, to construct a safe line and clean burn or move inside and completely put out.

Problem 14

Small Fire Burning Hotly in Small Dense Fuel Patch Surrounded by Area Where Line Is Easily Built:

(11)

Action Required:

If fuel, slope and wind will permit burning out line, drop back from dense fuel and build line in more open area where line can be constructed rapidly. Otherwise move inside and put out with dirt and trench by direct attack.

Why:

To encircle fire with line that can be more rapidly built and more easily held than in the heavy fuel area.

Supplemental:

Same problem exists if fire established in localized pile of logs, slash or dense patches of reproduction.

Fire Burning Near Side of Road, Stream or Other Barrier:

12

Condition:

Uniform slope and fuel.

Action Required:

First control fire on side away from barrier, allowing fire to burn to barrier or toward it until side of most threat is safe.

Why:

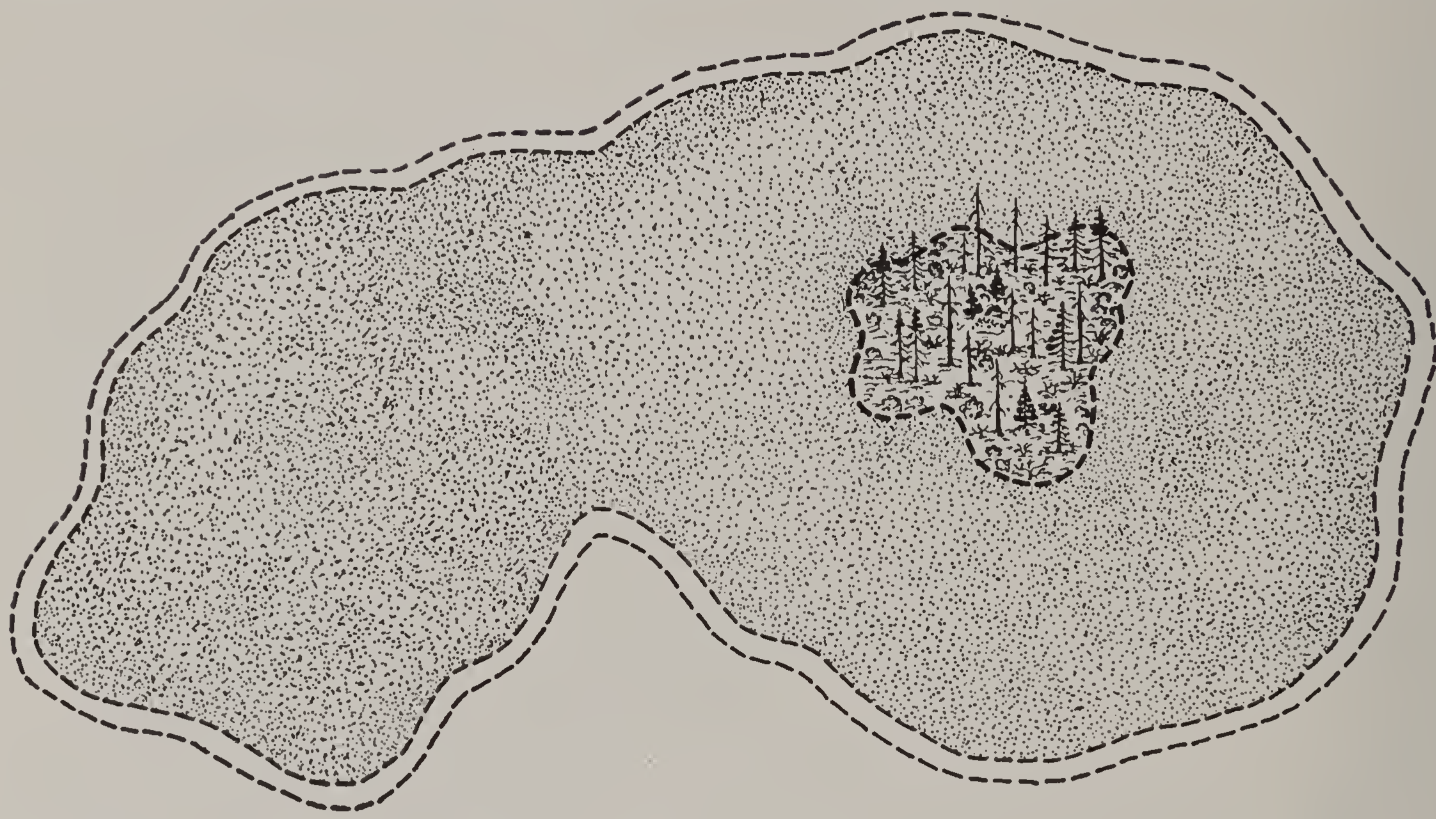
To take advantage of existing barriers and thus reduce length of line to be constructed and control time.

Supplemental:

It is essential that clean burning be done along existing barriers before the fire is considered controlled, unless barriers are of sufficient width to insure safety against spot fires and flaring across line.

Problem 16

Unburned Islands in a Small Fire, With Fuel Heavy Enough to Throw Spot Fires:



⑬

Condition:

Fire did not burn heavily enough to get a clean burn, and several small islands remain within the final control line.

Action Required:

Build continuous control line around the outside of each island. If they consist of small patches of singed reproduction or brush close to the outside control line, cut these down and scatter in burned area, if this can be done with reasonable expenditure of effort and time.

Why:

To remove the possibility of the fire later starting up in the incompletely burned territory and spotting over the control line. To have barrier down to mineral earth around all burned territory.

Problem 17

Small Fire in Slide Rock Country. Fire Established Under Rock Piles:

Condition:

Little dirt available. Water supply one mile from fire.

Action Required:

Clear line and trench around exterior boundary of slide. If shallow slide, dig fire out. If established deep in bed of boulders too large to handle, hold trench around outer edge and await decision of ranger as to whether or not a water line is to be established.

Why:

The only sure method to control is with water or to completely dig fire out. Build line around dangerous area of slide to safeguard against fire springing to life and spreading to outside fuel bodies.

Two or More Lightning Fires That Started Fairly Close Together Are Assigned to the Same Small Crew:

14

Condition:

Little precipitation came with the storm. Fires accurately located by lookouts' reports and three men are assigned to the job. Other fires in district made prompt follow-up unlikely.

Action Required:

If training of crew permits splitting up into one-man units, and fires appear to be one-man jobs, send one man to each fire. If one fire is obviously more dangerous than others, it may be advisable to use all three men on it until its spread is controlled. Then move two men to other fires. If two fires are seemingly worse than the third, it may be well to send two men to the most dangerous one, one man to second worst fire and defer action on third fire until one of the others is controlled. If crew, except foreman, are untrained as firemen, all three will go to first fire, put it under control, leave one man to mop up and the other two men will proceed to fire number two where the same procedure will be followed; when number two is controlled, the leader may proceed alone to fire number three.

Fire Too Big for First Attack to Control:

15

Condition:

Uniform spread, fuel, etc. Spreading too fast to hold line on head.

Action Required:

Scout fire to have information available when follow-up crew arrives. Stay with fire. Begin work at rear of fire and proceed on rear and flanks until help arrives. Fire may quiet down at any moment and one man's work may mean a great deal.

Why:

Make time and effort effective in partial control instead of making futile efforts to head the fire.

Supplemental:

If there is probability that fire can be kept out of high-danger fuel, attack at such points instead of rear.

Problem 20

Whether to Protect Personal Property in Building Already Doomed or to Put Suppression Effort to Prevent Spread of Fire:

16

Condition:

Fuel, slope, spread, etc., uniform. Fire originating in building but spreading to surrounding area.

Action Required:

Control fire, selecting key point for attack.

Why:

To hold fire and avoid danger of major forest fire, instead of making futile efforts to save property already doomed.

Problem 21

Protecting Improvements or Putting Suppression Effort to Prevent Spread of Fire:

Condition:

Slope, spread, etc., are uniform. Fire headed toward (a) dangerous fuel and (b) toward cabin, fence or other similar property.

Action Required:

First, control key point of fire as though no improvement problem existed; then consider improvements.

Why:

To hold fire and avoid danger of a major forest fire.

Supplemental:

If fuel conditions are uniform and not hazardous and very high improvement value is at stake, first attention to such property is justified. Likewise, a building may become a dangerous source of spot fires once it catches fire. A burning building creates a high column of heat which may carry spots long distances.

Good Practices in Selecting Point for First Attack Developed by Problems:

1. Use water or dirt for cooling down and checking hot spots. Problems 1 and 2.
2. Anticipate future control action when fire cannot be put out promptly. Problems 3 and 4.
3. Follow up temporary checking effort on fire with permanent clean line. Problems 5, 13 and 18.
4. Cut fire off from most dangerous fuels as first effort. Problem 6.
5. Where fire is established in explosive types of fuels, attack first to prevent it from emerging therefrom. Problems 1, 3, 4 and 7.
6. Confine fire to one major area rather than to let it develop two heads. Problem 8.
7. Locate and build lines and move rollable material so that roll across fire lines is eliminated. Problems 9, 10 and 12.
8. Leave neither islands nor other unburned material close to line. Problems 11 and 16.
9. To insure control within time limits, sacrifice area to make easy line construction and line that can be held. Problem 14.
10. Utilize existing barriers to full extent. Problem 15.
11. Use water for final suppression when dirt not available. Problem 17.
12. If whole fire can't be controlled, make work done effective on part of it. Problem 19.
13. Protect forest area before protecting improvements. Problems 20 and 21.

LINE LOCATION

After both fire and territory ahead have been scouted and key points for attack selected, the question of line location arises.

WHAT TO DO IN LINE LOCATION ON ALL FIRES

1. Speed of complete control is the objective. If the fire's edge is not too hot nor too irregular, work directly on the edge by scraping and digging back the burning fuel. Thus advantage may be taken of dead sections and reduce the time involved in clean-up burning.
2. When necessary to back away from fire's edge, balance probable extent of spread against the probable speed of line construction. Give ample time for construction and clean-up firing before fire reaches location.
3. Pick shortest line locations and easiest routes to expedite job.
4. Avoid sharp angles and undercut lines.
5. As far as possible, have fire back down to lines and give backfires uphill start unless line runs up and down slope, then fire from top down.
6. Take advantage of natural barriers.
7. Mark line locations.
8. Locate line as close to fire as practicable.
9. Avoid heavy fuel bodies. Locate line so as to place snag patches and heavy masses of fuel outside.
10. Encircle areas where spot fires are so numerous as to make impractical handling as individual fires.
11. Take advantage of open areas.

12. Take advantage of normal daily wind shifts.
13. In high hazard types, locate line close to fire edge even when very hot where men can work safely for short periods.
14. Under similar conditions where men cannot work safely, back up to leave time for line construction and backfiring.

PROBLEMS IN LINE LOCATION

Problem 1

A Fire Burning on a Moderate to Steep Slope:

17

Condition:

Mature timber and scattered groups of reproduction, fire crowning only occasionally in reproduction clumps. Greatest rate of spread uphill.

Action Required:

Fire should be attacked at head, then work down both sides of fire simultaneous to encircle fire at bottom. Locate line near or along edge of fire, clean burning where needed as line is built.

Why:

To cut off point of most rapid spread.

How to Locate Line to Control Fires That Spread Into a Series of Elongated Fingers:

18

Condition:

Fire has made hard run and developed long fingers with unburned area between. Fire has slowed down.

Action Required:

If time and conditions permit, cold trail and mop up; otherwise, tie ends of the fingers together with shortest feasible control line and burn out promptly the cover between this line and the burned area whenever:

a. To control by direct attack the edge of the ragged burn may be too large a job for available forces to complete before next burning period, or

b. To control the burn in its irregular shape may involve excessive expenditure when contrasted with the values that would be saved.

Why:

Clean-up burning is preferred. To make control possible within the first burning period and with a reasonable expenditure of effort. The reduced length of control line will also be easier to hold.

Supplemental:

Same problem exists when too many spot fires develop in a limited area to control individually. Encircle them inside fire line.

How to Control Rear of Fire on Very Steep Slope About Midway Between the Crest of Ridge and Ravine at Foot of Slope:

Condition:

No roads or trails traverse area. Wind moderate. Fire spread fairly rapid, mainly up slope; trenching very difficult because of rock. Much fuel that will roll.

Action Required:

If distance between lower edge of fire and base of slope is not too great, locate line at bottom of slope; then start at top and bring line down both sides; backfire promptly after construction.

Why:

To prevent loss of line due to burning material rolling over any line constructed under the fire on the steep side hill. Location at base allows more time for construction and backfiring and can be held more easily and certainly.

PROBLEM 4

How to Locate Line to Control Lower Flank of Fire on Steep Ground:

Condition:

Fuel brush and timber. Spread minimum. Ravine dry. Side slopes steep. Wind has driven fire diagonally up slope.

Action Required:

Locate line on opposite side of draw from rear of fire; proceed along ravine until rolling material from head of fire cannot cross rear line; locate line up flank, converging on head of fire.

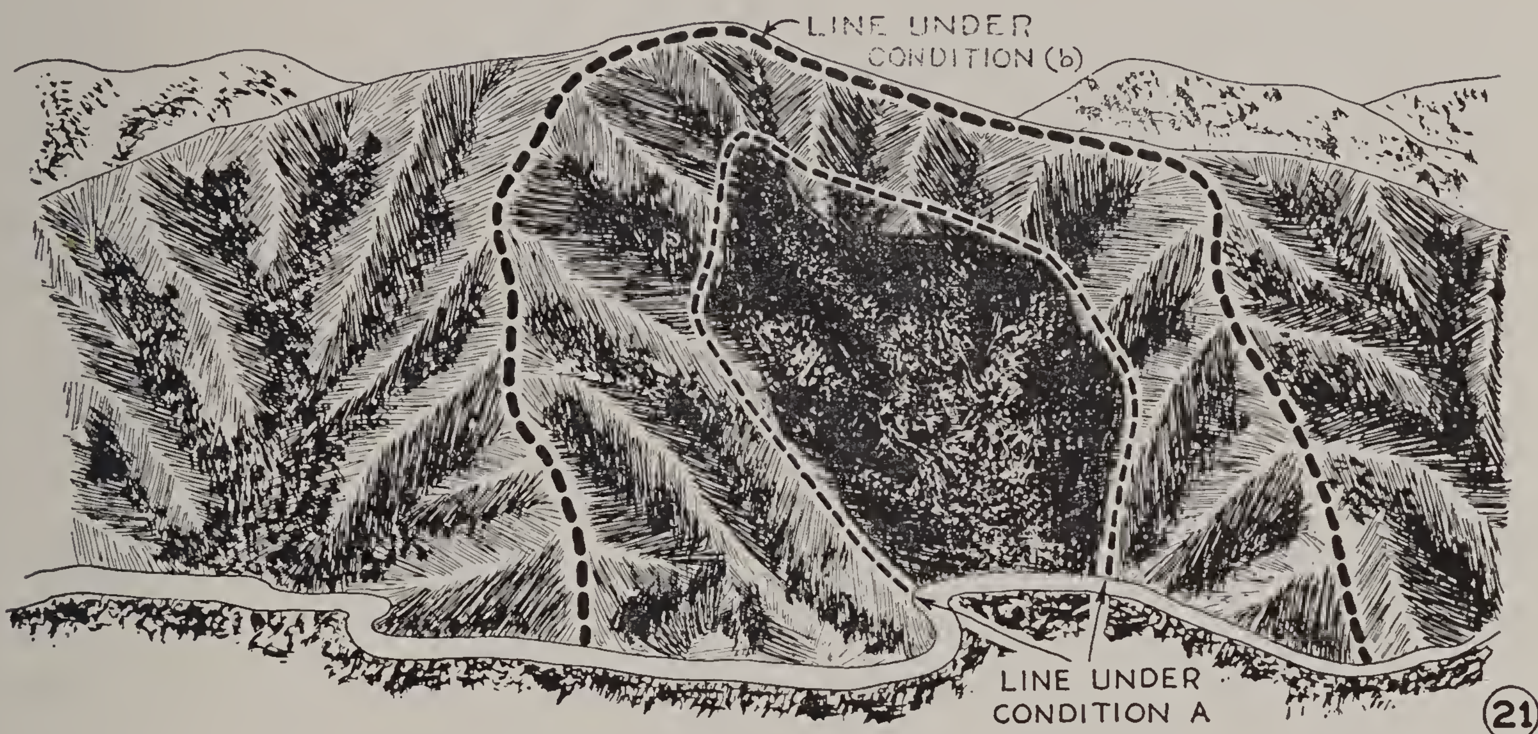
Why:

To prevent burning material from rolling over control line.

Supplemental:

Wide running stream may be used as line without worrying about rolling material but must be patrolled to care for trees or snags which may fall across stream.

How Existing and Prospective Rate of Spread Affects Distance of Control Line From Fire Edge:



Condition (a):

Fire established on moderate slope. Medium uniform fuel on entire slope. Wind direction steady. Rate of spread medium. Edge of fire fairly straight. No serious danger of rolling; wind not likely to change direction for several hours.

Action Required:

Locate line as near edge of fire as head will permit, burning out as line is built.

Why:

Conditions predictable far enough in advance to insure holding of line; shortest line most quickly completed by working close to fire.

Condition (b):

Fire conditions as above, except wind gusty, sudden changes in direction, spread of fire by spurts, edge of fire irregular. Outlook: wind direction likely to switch at any moment, gustiness likely to continue.

Action Required:

On each flank of fire, drop back to side spur or ravine far enough from fire so that, with men and tools available, entire line can be built and backfired before the fire reaches any part of line. Necessary to estimate behavior of fire for definite period.

Why:

A tricky fire will probably cross and flank line built too close to edge.

Problem 6

How to Control Head of Fire Burning Rapidly Up Slope and Nearing Sharp Crest of Ridge:

Condition:

Fire running up hill rapidly in moderately dense brush, reproduction, mature timber or old burn.

Action Required:

Drop just over crest of ridge away from slope on which fire is running and build line. Trench if necessary to prevent rolling material from getting over the line. Clean burn promptly after construction.

Why:

To prevent main fire from sweeping over control line; to permit clean burning of line with initial backfire; to provide a wide burned outline when fire reaches crest; to create a counterdraft that will slow up main fire and cause sparks to fall back in burned area.

Problem 7

How to Locate Line to Control Badly Fingering Fire Nearing Top of Well-Defined Ridge, and Which Is Not Expected to Reach Ridge Before Heat of Next Day:

Condition:

Night approaching. Relative humidity increasing. Getting cooler. Fire dying down. The ridge is between fire front and a well-defined ravine. It is impracticable to cold trail head of fire due to the numerous fingers. Humidity too high to obtain clean burn down slope. Uniform cover of fuel.

Action Required:

Go to the ravine and construct control line along it but on side opposite from fire; tie in flanks to barriers or main fire and backfire uphill.

Why:

Location of line in ravine in preference to ridge top will result in a more thorough backfiring job, since a backfire will clean burn uphill during periods of high humidity. Location of line on side of ravine opposite from fire is

necessary to prevent burning material from rolling across line. Use ravine bottom as a catcher of rolling embers.

PROBLEM 8

How to Locate Line Near Snags Threatened, But Not Yet on Fire:

Refer to sketch No. 8 for First Attack Problem 6.

Condition:

Rate of spread moderate. Wind light. Topography level.

Action Required:

Locate fire line to leave all snags outside the completed line.

Why:

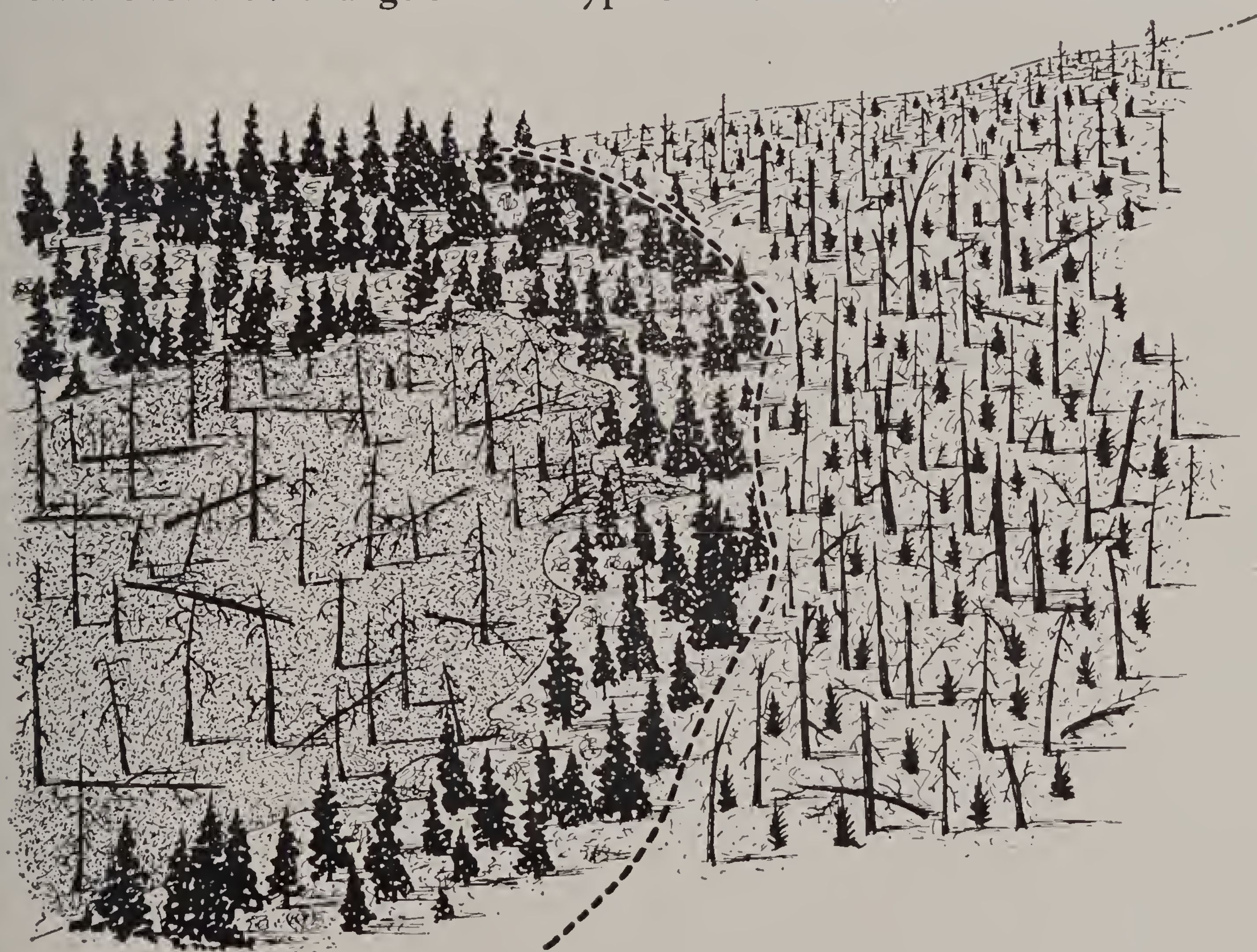
To keep snags from catching fire and spreading fire on ahead by burning embers or sparks.

Supplemental:

When snags are so close to fire edge that the main control line cannot be located to exclude them, good practice is to clear all fuel around each snag or groups of snags over a sufficient width to prevent them from igniting.

PROBLEM 9

How Pronounced Change of Fuel Type Outside Fire Affects Location of Control Line:



23

Condition (a):

Fire established in mature mixed timber type. Spread moderate. Wind direction steady. Dense fuel with many snags and down logs some distance ahead of fire. Direct attack on head of fire impossible or dangerous.

Action Required:

Locate line across head of fire in timber, far enough from edge of snag patch so that under existing conditions spotting into snag area unlikely. Locate as close to fire edge as possible, leaving time to complete and backfire line.

Why:

Resistance to control in snag area greater than in green timber. Key point is to confine fire to green timber.

Supplemental:

Solution is same where fire threatens to move from any type with less resistance to control to any type with greater resistance to control.

Condition (b):

Fire established in dense fuels. Moderate or rapid spread. Wind direction steady. Green timber area lies across head of fire. Flanks and rear of fire will remain in heavy fuel for long distance. Direct attack on head impossible or dangerous.

Action Required:

Locate line at or just inside edge of green timber, backfiring as built if crowded for time; or when completed, if not crowded. Locate line for rear and flanks in heavy fuel area as governed by heat of fire, topography and rate of spread. Limb trees inside to prevent crowning.

Why:

Attempt to control head of fast moving fire in high-resistance type dangerous and ineffective. Select location where best chance for success, without needless sacrifice of area or effort.

Supplemental:

Same solution applies to fire which is headed from any high-resistance type to any type of lower resistance.

Problem 10

How to Locate Line With Reference to Burning Snags Inside Fire, Too Hot to Cut Down:

Condition:

Topography level. Wind light. Rate of spread moderate.

Action Required:

Locate line far enough from fire to catch blowing sparks and embers coming from burning snags, and snag itself when it falls or is cut. Maintain constant watch for spot fires.

Why:

To prevent loss of line caused by embers blowing into unburned area or by snag falling.

Problem 11

How Heat of Fire Affects Distance of Control Line From Fire Edge:

Condition (a):

Small fire established in large slash area or other heavy fuels. Road near flank will not automatically stop fire but can be held. Heat uncomfortable but not unbearable for few minutes at a time.

Action Required:

Use dirt or water to cool down fire, using individual workers very short period at a time. Short relays on direct attack.

Why:

Facing hot fire necessary to prevent major fire involving whole fuel or slash area. No danger to life, since ways of escape open. Utilizes existing barrier.

Supplemental:

Same solution where necessary to keep hot fire from getting into high-resistance type or to save structures.

Condition (b):

Fire established in large, heavy fuel area, full of down logs. No barrier near fire edge. Night time. Rate of spread slow, but volume of heat great.

Action Required:

Locate line beyond zone of intense heat, but close enough to minimize length of line.

Why:

Nothing to be gained by making work needlessly uncomfortable.

Supplemental:

Same problem with any slow spreading, but very hot fire, where key problem is sureness rather than speed of control.

How to Locate Lines With Reference to Natural or Man-Made Barriers:

Condition:

Fire burning just above canyon in steep country. On one spur extending to canyon is a trail leading from the main ridge which parallels canyon; along this ridge is a series of large rock outcrops making a barrier which will at least temporarily stop main head of fire.

Action Required:

Utilize the trail as a control line on the one side and tie the bluffs together at the top for the upper line.

Why:

The use of existing natural or man-made barriers as parts of control line expedites the control of a fire through reducing the size of the job. Trails, roads, streams, barren areas and fire-breaks usually make easier and safer lines to patrol.

Problem 13

How to Locate Lines to Control Narrow Head of Fire, Too Hot for Direct Frontal Attack:

25

Condition:

Rapid rate of spread up steep slope; uniform fuel, mature timber; considerable young growth.

Action Required:

Locate and construct line by flanking attack around head of fire, avoiding sharp angles.

Why:

When there is a sharp bend in a line around the head of a hot fire, danger of spotting is increased greatly, since the intensity of the fire is concentrated at a point instead of being distributed along a wider front. Also, wind from any one of three directions will tend to blow the fire over some portion of the line in the vicinity of the sharp angle.

Supplemental:

Line location along trails, roads, ridges, streams, etc , involving sharp angles, should likewise be avoided.

Problem 14

How to Locate Line in Country of Varied Fuel and Topographic Conditions:

Condition:

Fire spreading too rapidly to permit close frontal attack. Steep, rugged country with occasional open ridges broken by heavily timbered canyons.

Action Required:

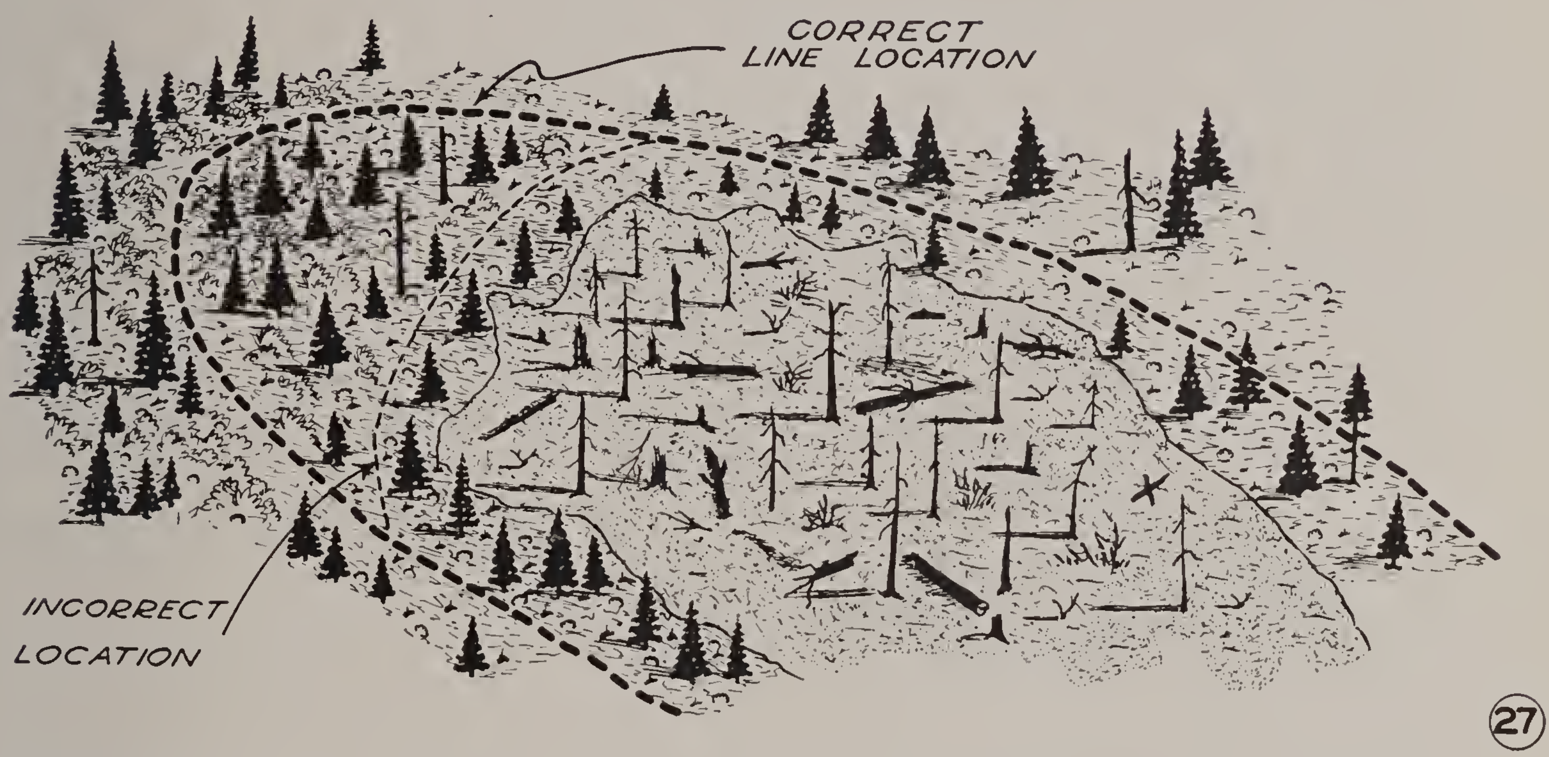
Locate line on most open and smoothest ridge or canyon within practicable distance of fire considering its probable rate of spread. Avoid heavy fuel and ridges so rough as to make line construction slow and difficult.

Why:

To facilitate the construction and holding of the line with the minimum of effort and the maximum possibility of success; to obtain sureness of control even at a possible sacrifice of area. *Caution:* Such tactics are dangerous. Must be used *only* by a well trained, experienced fireman and should be replaced by more direct attack if at all possible.

Problem 15

How to Locate Line to Control Fire Moving Forward Along a Uniform Front Burning Too Hot for Close Frontal Attack:



Condition:

Uniform fuel. Level ground. No topographical features, such as ridges and ravines, to influence location of line. Fire any size. Rate of spread rapid and expected to continue.

Action Required:

Locate line a sufficient distance ahead of the fire front so that there is ample time to build and backfire before the front of the fire reaches it. Locate the line at an angle to axis of fire spread, so that only a small portion of main front will hit line or backfire during any given short period.

Why:

To reduce the size of the fire front that must be stopped by the control line at any given time.

Problem 16

How to Take Advantage of Normal Shift of Wind Direction in Canyons:

Condition:

Early evening. Hour of day approaching for normal shift of wind from up-canyon to down-canyon draft. No extreme conditions of fuel or weather. Fire in narrow, steep canyon bottom. Fire can be controlled without difficulty with forces available before midnight.

Action Required:

Locate line for first work at rear or down-canyon side of fire out of heat and smoke. Work around both flanks of fire, closing in on up-canyon side as the wind shifts to down-canyon draft. Stay close to fire edge and clean burn line as built.

Why:

Successively working sections of the fire while they are quiet, permits more effective production of line by allowing men to work under conditions of minimum heat and smoke, and permits line to be more easily held. Line first worked has cooled down and requires minimum attention to prevent loss when the wind shifts to down-canyon direction. The portion of fire which was the head on arrival, becomes the rear when the wind shift occurs and attack at this time is more easily made.

Good Practices in Line Location Developed by Problems:

1. Locate line as near fire edges as possible. Problem 1.
2. Make line as short as possible. Problem 2.
3. Locate fire line so rolling material cannot cross. Problems 3 and 4.
4. Where fire is spreading rapidly or is very hot, or when gusty, shifty wind makes direct attack uncertain, locate line to give time for line construction and backfiring. Problem 5.
5. Locate lines to give uphill start to backfiring. Problems 6 and 7.
6. Block off high hazard types where possible by leaving outside of lines. Problems 8 and 9.
7. Locate lines far enough from burning snags to enclose snags when felled and to catch sparks. Problem 10.
8. In high hazard types, locate line close to fire edge, even when very hot, where men can work safely for short periods. Problem 11a.
9. Under similar conditions where men cannot work safely, back up to leave time for line construction and backfiring. Problem 11b.
10. Capitalize on all existing barriers in line locations. Problems 11a and 12.
11. Avoid sharp angles in line. Problem 13.
12. Select most open locations. Problem 14.
13. In country without definite topographic features, use oblique lines for frontal attack. Problem 15.
14. Take advantage of normal daily shift between up-canyon and down-canyon drafts. Problem 16.

LINE CONSTRUCTION

THINGS TO DO ON ALL FIRES

1. Make line no wider than necessary. Excess width is waste.
2. Clean all lines to mineral soil for all or part of width, according to needs of particular job.
3. Dispose of material so as not to interfere with mop-up.
4. Protect undercut lines against rolling material.
5. Continue work day or night.

PROBLEMS IN LINE CONSTRUCTION

Problem 1

How to Dispose of Material Removed in Line Construction:

Condition (a):

Work is done directly on the fire edge because it is spreading slowly.

Action Required:

All blackened or charred material should be scraped into the burned area; whatever is cut or scraped away on the portion of the line outside of the burn should be put on the outside of the line. The charred fuel should be scattered in the burn (not piled or decked) and not covered with dirt.

Condition (b):

Line constructed some distance away from the edge of the fire.

Action Required:

If the removed fuel is light, it should be thrown whichever way will make for most rapid line construction, care being taken not to build up heavy piles of fuel inside of the line and close thereto. If the fuel is needed in backfiring, it should be placed inside the line.

Why:

To avoid building up the supply of fuel close to the line with consequent increased danger of the fire getting across; to dispose of material in easiest way.

Problem 2

How to Use Relatively Narrow Line to Speed Control:

Refer to sketch No. 40.

Condition (a):

Line narrower than desirable through seedling reproduction, which must be backfired or to which fire will back. Considerable danger of spotting or flaring over line.

Action Required:

Throw dirt or use water to keep fire out of crown immediately adjacent to line.

Why:

To reduce intensity of burning and to minimize danger of spotting or crowning over line.

Supplemental:

Same problem if brush or grass involved.

Condition (b):

Down log or stump inside fire near line. Danger of spotting or rolling.

Action Required:

If already afire, cool down with dirt or water. If not afire, try to keep fire out with temporary line.

Why:

To gain time until special attention can be given to eliminate threat.

PROBLEM 3

Protecting Most Inflammable Fuels Outside Fire Line:

Refer to sketches Nos. 51 and 52.

Condition:

Fire close to rotten stumps, snags or logs. Main fire throwing spots.

Action Required:

Use dirt or water on material outside line to minimize danger of spots.

Why:

Such fuels most dangerous focal point for spot fires.

PROBLEM 4

How to Trench to Handle Rolling Problem:

Condition:

Fire backing down moderate slope in needles, cones and scattered wood fragments; undercut line needed; dirt available.

Action Required:

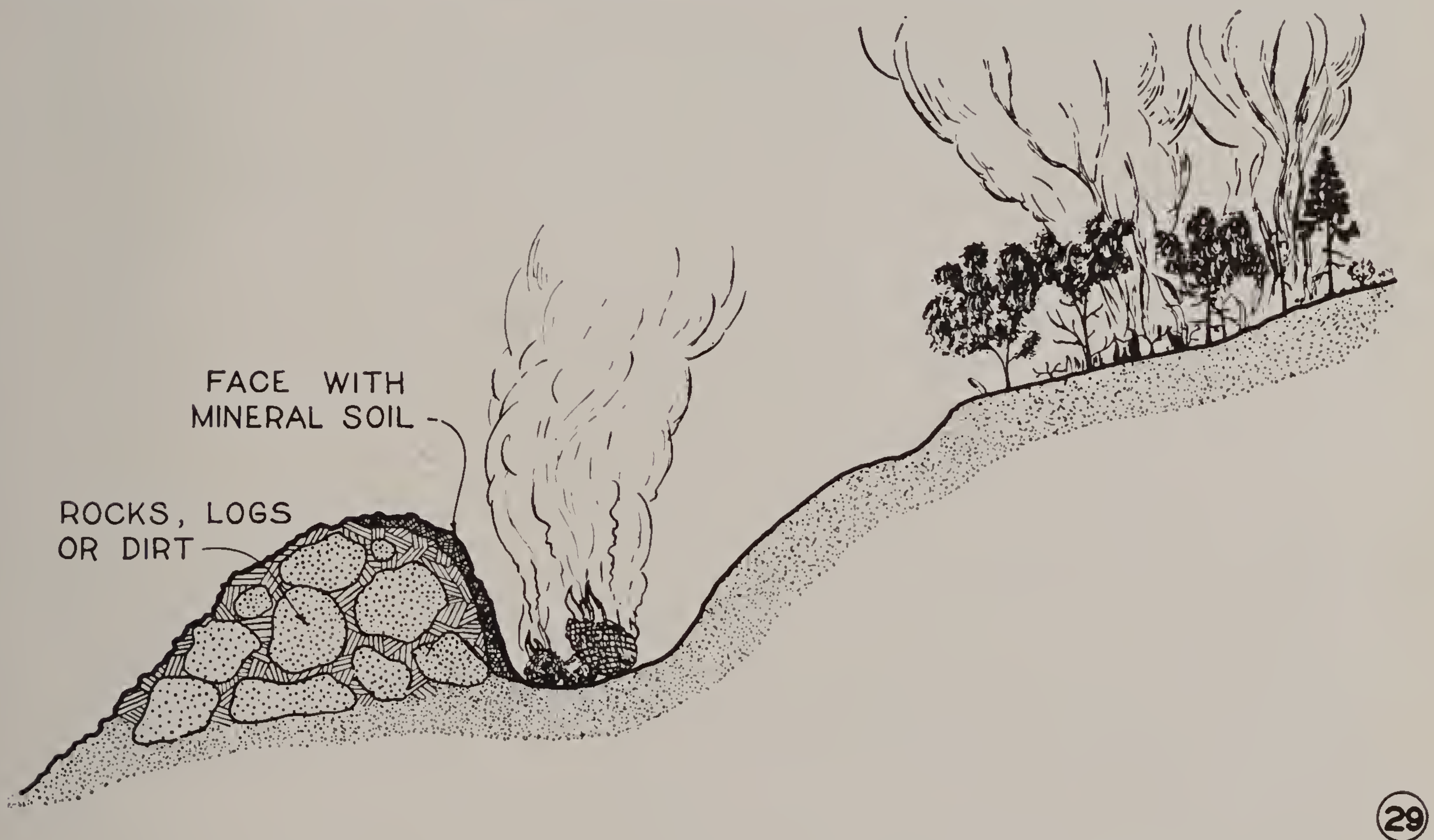
Convert fire line into trench by excavating clean mineral soil and piling along lower edge. Duff may be used to form part of berm but should be completely covered with mineral soil.

Why:

To catch rolling, burning material.

PROBLEM 5

How to Build Trench to Handle Rolling Material in Rocky Country:



Condition:

Fire on steep rocky slope, with material that will roll when disturbed by fire, and undercut line necessary.

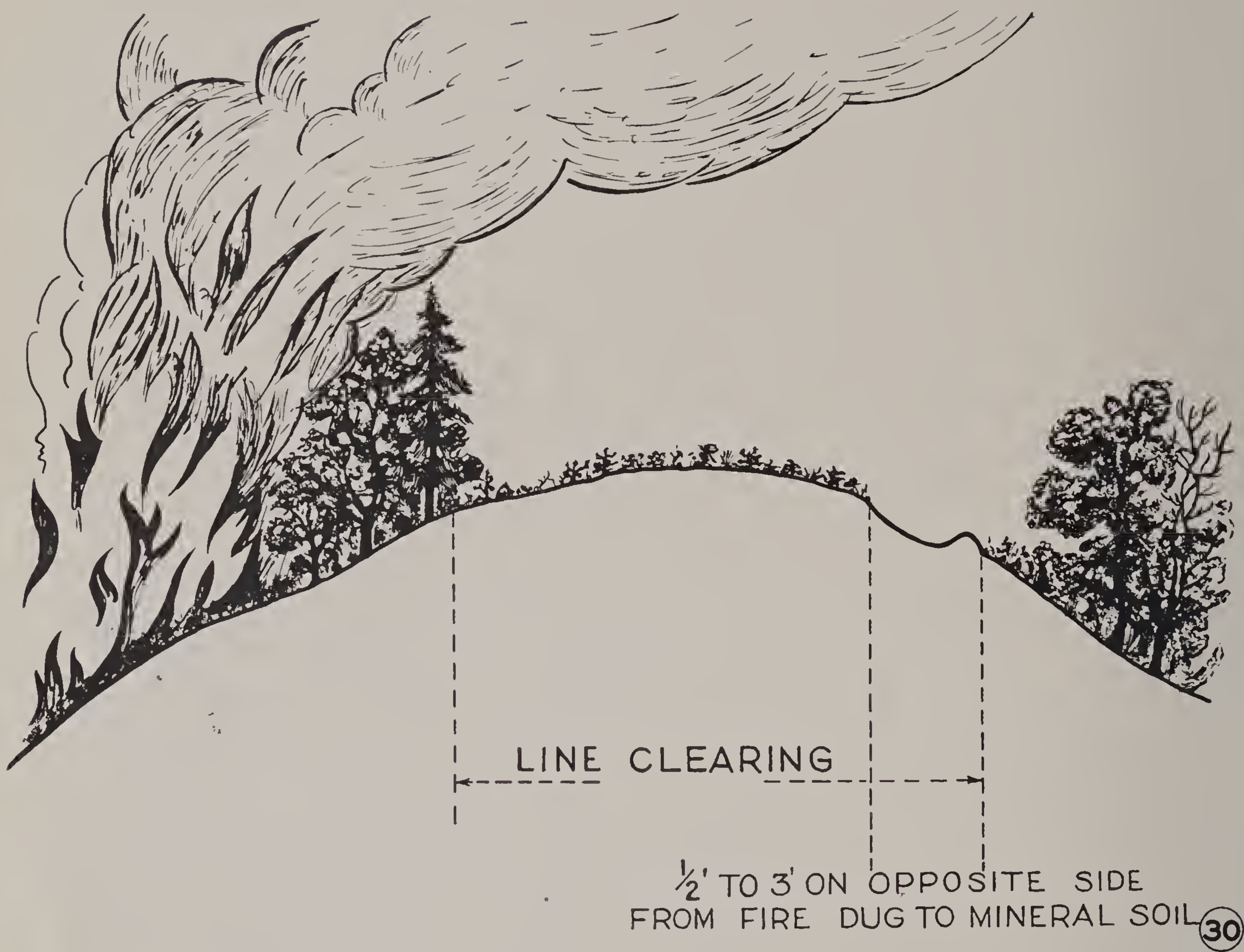
Action Required:

Convert fire line into trench as in previous problem, using stones, small logs or other debris to form foundation of berm. Cover face with mineral earth. If necessary use trees, stakes or stones to hold logs or large pieces of fuel in place.

Why:

To build effective barrier against rolling material faster than is possible with dirt alone.

Effective Use of Firebreak (Driveway or Other Cleared Strip):



Condition:

Fire line to be backfired or not. Light cover of grass and weeds on clearing.

Action Required:

Clean fuel from clearing or right-of-way on strip one to three feet wide on edge of break away from fire.

Why:

To obtain full effectiveness of entire width of break.

Temporary Lines to Check or Stall Fire and Gain Time:

Condition (a):

Major fire has run up steep, heavy brush slope and has slopped over crest in stringers and spots too ragged and numerous to control by direct attack. Considerable time needed to prepare line at base of slope in advance of fire and await favorable conditions for clean-up firing.

Action Required:

Hot spot threatening stringers and spots to check them while constructing backfire line.

Why:

To gain time for construction and clean-up of main fire line.

Condition (b):

Fire line will leave snags inside but close to line. Danger of spotting great if they catch fire and time is insufficient to fall snags.

Action Required:

Build temporary lines around individual snags or groups of snags.

Why:

To guard against spot fires and other snag dangers until time can be gained for final control.

Condition (c):

Fire in duff or matted needles. Forces available insufficient to construct final control line at once.

Action Required:

Put in scratched line. Later, when main fire is controlled, strengthen scratched line or build new and final line if first line lost.

Supplemental:

Generally, unburned hazards inside lines will be immediately disposed of, but when crowded for time on initial attack "stalling" is good practice.

PROBLEM 8

Supplemental and Alternate Lines For Use Only if Main Fire Line Is Lost:

Condition (a):

Jackpots of heavy fuel and rotten down logs near but outside line which have not, but are likely to catch fire. Too large to cover with dirt and water not available.

Action Required:

Build line back of fuel mass, tied in at both ends to main line.

Why:

Advance preparations will greatly speed control if spots become established in logs.

Supplemental:

Same solution if slash piles or any other extra hazardous fuel close to line which cannot be dirted or wet down.

Condition (b):

Main fire line to be backfired in edge of timber to attempt holding head of fire coming out of heavy fuel. Danger that impact will cause breaks in line but not simultaneous loss of large sections. Anticipated that breaks can probably be controlled as individual spots, but not certain.

Action Required:

If labor available reduce fuel hazard inside line by breaking up concentrations, limbing trees, etc. If this is impractical, prepare to drop back a safe distance and build second line parallel to main line.

Why:

If slop-overs and spots not controllable individually, additional area bound to be lost. This advance preparation will save critical time.

Good Practices Developed by Line Construction Problems:

1. Scrape or throw burning or charred fuel into fire. Problem 1.
2. Dispose of material removed in line construction where it will facilitate backfiring, shorten burning period and decrease difficulty of mop-up. Problem 1.
3. Effectiveness of a given width of line can be increased by using dirt or water to cool down adjacent fire and to cover fuels on outside of fire line. Problems 2 and 3.
4. Any undercut line must be designed to protect against rolling material. Problems 4 and 5.
5. When using an existing fire line, not clear of low fuels, obtain full effect of whole width of firebreak by cleaning a line to mineral soil on edge of break away from fire. Problem 6.
6. Use temporary lines to slow down fire when additional time is needed in which to construct final line. Problem 7.
7. To insure prompt control of fire from possible ignition of fuel outside of main control line, construct alternate lines around accumulations of particularly dangerous material. Problem 8.

SPECIAL LINE CONSTRUCTION METHODS

COLD TRAILING

To cold trail is to build a line along the edge of a fire that has ceased to spread rapidly and is smoldering along intermittent sections of its edge. Ordinarily, clearing can be relatively narrow and line is constructed one-half in the burn and one-half outside. All smoldering or charred material should be thrown well back in the burn. Material not burning may be thrown outside. Duff is scraped into the burn and scattered well inside the line. Digging is usually directly at the line edge. Only enough clearing is done to provide working space and insure against flare-ups into brush or low-hanging limbs.

In cold trailing, be sure that:

1. No embers are cast into unburned area.
2. Charred and smoldering material are well scattered to prevent later flare-up.
3. No fingers of smoldering material are overlooked.
4. Material left inside of line is not in contact with live fire, or is so thoroughly burned that it cannot flare up; otherwise cut it out and scatter.
5. Islands of unburned or singed material are treated to prevent crowning or ground spread, and the islands are cold trailed.
6. No work is done on sections of the fire's edge which are out, but a cold trail is trenched on all of live edge.
7. On undercut lines gutters are provided if there is any chance of burned material rolling across line.
8. All of apparently cold edge is felt out by experienced man.

HOT SPOTTING

Hot spotting is a practice often used in cold trailing attack (but not necessarily limited to such situations), by which small crews are sent ahead to dangerous points on the fire edge to control or check the threatened revival of spread at those points, and to knock down and hold localized flare-ups. Intermediate sections of the edge of the fire of little immediate concern are left to the cold trailing crews. In general, the problem is to hold the fire in place until control can be effected.

In hot spotting, the usual technique is the same as in cold trailing, except that it is often necessary to increase the width of line and go to extremes in the scattering

of cut material to prevent revival of the fire. Often a hot spotting crew can cover effectively several hot spots by leaving behind one or more members of the crew at each spot after control is reasonably assured, to maintain safety until the cold trailing, or regular line building crew arrives.

FEELING OUT

In low and thin fuel, such as the less dense stands of huckleberry, snowbrush and similar low inflammability types, cold trailing need be done only on those sections of the edge of the fire at which signs of fire can readily be found. Sections that appear to be dead are not trailed, but are carefully gone over by an experienced man who feels the edge of the burn with his bare fingers to be sure that no fire is overlooked. Feeling out can save vast quantities of work but must be done by an experienced and reliable man; and the line must be checked frequently for signs of fire. In areas of deep duff it should not be relied upon, except as a temporary expedient.

ADDITIONAL GUIDES TO LINE CONSTRUCTION PRACTICES

The construction of fire lines in any fuel type involves removal of burnable material from a strip wide enough, given mop-up and patrol, to prevent fire spreading beyond the fire line. It is essential that all or part of the line be cleared all the way down to mineral soil. Effective line widths vary with the volume of the fuel, that is, density and height of fuel; its inflammability; the wind direction and conditions of weather and topography which influence rate of spread.

The amount and character of burnable dead or down debris and live vegetative cover determine to a large extent the rate of spread and resistance to control. Fuel types are based on the foregoing, and the ones listed in the following tables are those most generally encountered in the construction of fire lines.

The table gives general guides for the minimum and maximum line widths. The minimum is a guide applicable to the rear or other slower burning sections of a fire. The maximum is applicable where fire is spreading rapidly uphill under severe burning conditions.

Certain tools are most suitable for speedy and safe line construction in different cover and fuel types. The best tools for such use in the several types are shown in the table. Other tools are commonly needed for work other than line construction, such as mop-up or patrol, which may be done at the same time as line construction. For example, in light duff or grass type, the council tool is shown as most effective for line construction. But, for a crew working in this type, a shovel or two and a pulaski may be needed for throwing dirt or cutting out logs. The larger part of the tools on line construction should be of the kind indicated. The number of each kind of the various tools needed to outfit crews is left to decision by forests or ranger districts in accordance with local conditions of fuel and cover.

Failure to recognize and take precautionary measures against certain conditions and occurrences has often resulted in losing a line or a fire. Some of the more common dangers for which to watch when working in each fuel type are given in the final column of the tabulation of fuel types and tools.

SPECIFICATIONS FOR LINE CONSTRUCTION

Principal Fuel Types, Total Cleared Width, Width Cleared to Mineral Soil, Most Effective Hand Tools and Special Danger Points in Each Type

Fuel Type	Total Width Cleared	Width Cleaned to Mineral Soil	Most Effective Hand Tools	Special Danger Points
1. Low grass* (Cheat)	None	Beat or whip out	Wet sacks, pine bough, shovel	Dried dung. Dead wood.
2. High grass (Bear grass, etc.)	1–2½ ft.	½–1 ft.	Council, Pulaski, shovel	Dried dung. Dead wood.
3. Pine needles	None	½–1 ft.	Council, Pulaski, shovel	Rolling cones, hollow roots, dead roots, punky logs, stumps.
4. Light brush—grass	2–4 ft.	½–1 ft.	Pulaski, Council, axe	Dried dung, roots, rolling embers.
5. Slash	4–20 ft.	1–2 ft.	Shovel, Pulaski, DB axe, saw, sledge and wedges	Rolling chunks and cones. Spot fires, roots across line, rolling logs, punky logs and stumps. Fire overhead.
6. Ceanothus brush	Min. height of brush to 6 ft.	½–1 ft.	Pulaski, axe, shovel	Brush stools, spot fires, burning roots, reburn.
7. Sparse or thin mixed brush & reproduction	Min. height of brush to 6 ft.	½–1 ft.	Pulaski, shovel	Rotten wood, rolling material, roots, buried logs, spot fires.
8. Dense seedling, sapling and small poles, 4″–8″	2–6 ft.	½–2 ft.	Pulaski, shovel, saw	Moss, low limbs, roots, overhanging foliage, punky logs and stumps. Reburn inside, spot fires.
9. Open mature green timber	2–4 ft.	½–2 ft.	Pulaski, axe, shovel, saw, sledge and wedges	Moss, low limbs, snags, buried rotten roots and wood, spots.
10. Dense mature timber	2–4 ft.	½–2 ft.	Pulaski, shovel, saw	Dead roots across line, moss on standing trees, falling leaves, low limbs and knot holes in standing trees, snags, reburn inside, spot fires.
11. Old burn, with lots of snags and down logs	4–8 ft.	½–2 ft.	Pulaski, axe, shovel, saw, sledge and wedges	Rotten stumps and logs outside and near line, falling or sliding snags, roots, spot fires, rolling chunks.
12. Heavy duff	1–2 ft.	Entire	Pulaski, shovel	Buried logs, roots, etc. Deceptive material which looks like earth but is decayed vegetable matter.
13. Lone snag	2–4 ft.	½–2 ft.	Pulaski, shovel, saw	Spot fires, rolling embers on lower side, sliding when snag falls.

* Scattered brush in grass or groups of reproduction in needles does not change the fuel type, since the problem of fire line construction remains essentially the same.

In any mature timber stand, the fuel on and near the ground determines fuel type. In any stand, snags are a special source of danger.

SPECIAL MACHINERY FOR FIRE LINE CONSTRUCTION

The faster a line can be constructed around a fire, the smaller the area and the less trouble in holding the fire. Trail builders and tractors can do the work of many men on areas adapted to the use of these machines, and can do it rapidly. Such machinery, in addition to trenchers and plows, should be taken to fires and used on all portions of the fire perimeter where such use will expedite control.

Tank trucks can and should be used where available to knock down the blaze and retard spread. The use of water alone *should not be depended upon* in lieu of a control line except in light grass cover, but must be followed by close inspection and prompt line construction with hand or power tools to make sure the fire is surrounded and will stay out.

BACKFIRING OR CLEAN-UP FIRING

Clean-up firing or backfiring as interpreted in this Region, implies any intentional burning done between the fire line and the fire edge whether the distance is inches or chains.

Clean-up firing is used as a means for making lines safe by burning material inside the lines which otherwise would be a menace. Decision as to whether burning out is feasible in each case depends upon whether this method is safer and quicker than other possible treatment. Likewise, when the line is considerable distance away from the fire, fuels on the area between the line and the fire must be isolated or removed, else the oncoming fire may rush against and cross the line. Usually burning out or backfiring is the only practical means for accomplishing the desired result.

Ordinarily no backfiring or clean-up burning will be done on smoke-chaser fires or fires in the class A stage. Therefore, the problems and text in this chapter refer to backfiring on larger fires.

The sketches in this chapter purposely exaggerate the distances between the fire and the fire line. This is done to give emphasis to the point in each illustration. Certain problems in firing out lines are described as dangerous and to be used only as a last resort. Others are explained which likely will be used very infrequently.

Readers are cautioned to observe the principle that backfires should be no farther away from the main fire than is absolutely necessary to assure greatest probability of holding the line. Likewise, firefighters must remember that any fire is dangerous and that the job is to put fire out. If backfiring will expedite control and lessen the cost of suppression and mop-up, without materially increasing the amount of damage to forest cover, then backfiring should be done. Good judgment is necessary.

What to Do in All Backfiring:

1. All control lines except those at edge of fire must be burned out or all inflammable fuel between the fire and the line otherwise removed.
2. Where possible, start backfires on higher portion of line so operation will proceed downhill.
3. There is a best time for firing to be watched for, recognized and seized.
4. Chances must sometimes be taken in backfiring if fires are to be controlled within constructed lines.
5. If safety of men is assured, better to gamble on emergency backfire than to lose line to main fire.

PROBLEMS IN BACKFIRING.

Problem 1

How to Backfire When Front of Fire Is Approaching Ridge:

Condition:

Medium fuel type; wind up slope; control line is located 100 to 200 feet over crest.

Action Required:

Promptly set backfire along line as built even if general wind direction is opposed.

Why:

Line is properly located so that backfire can be started uphill and will burn against wind. Burn while humidity is low as indicated by active spread of main fire. As main fire nears crest it will create an updraft which will draw backfire toward it.

Timing and Aggressiveness in Backfiring; Identifying and Acting on Favorable Conditions:

Condition:

Fire on brush, reproduction or grass type slope, with uneven edge; burning briskly up side ridges and creeping around in canyons. Fire line possible on main crest; mid-afternoon wind blowing across ridge toward fire.

Action Required:

Build line just over ridge top and set backfire along fire line as promptly and as rapidly as possible.

Why:

Take advantage of favorable wind and humidity condition, and push backfire aggressively to complete before wind changes and humidity increases and fire lies down.

Supplemental:

Same problem exists for any type or slope when line is ready to backfire and when normal outlook is that with nightfall main fire will lie down, leaving ragged, irregular line, difficult or impossible to cold trail.

How to Backfire Under Adverse Conditions:

Condition:

Line completed at too late an hour to obtain easily a fast and clean backfire; fire along ridge in the brush or reproduction.

Action Required:

Stimulate backfire by spraying oil on fuel through use of such equipment as the flame thrower. Set auxiliary fires short distance down the slope, which will burn uphill toward the line, using flame throwers or torches if the cover is safely penetrable; shovel in burning embers if it is not. If this special equipment is not available, set fires in spots of heaviest fuels by any means available.

Why:

Necessary to backfire or face blowup of fire with probable loss of line during next burning period.

Supplemental:

Same situation develops because of timidity in backfiring while conditions favor ready burning.

Problem 4

Timing Backfire to Utilize Suction From Main Fire:

Condition:

Backfiring against strong wind. Any readily inflammable fuel type.

Action Required:

Backfire just before the pull of the draft from the main fire is evident.

Why:

The fact that the onrushing fire creates a back draft in its path is extremely helpful in backfiring at close quarters. The timing of the setting of the backfire is important. The hotter the main fire, the sooner the back draft is felt.

Problem 5

How to Use Water in Backfiring:

Condition:

Backfiring against wind; water available; brush cover, open timber or grass land.

Action Required:

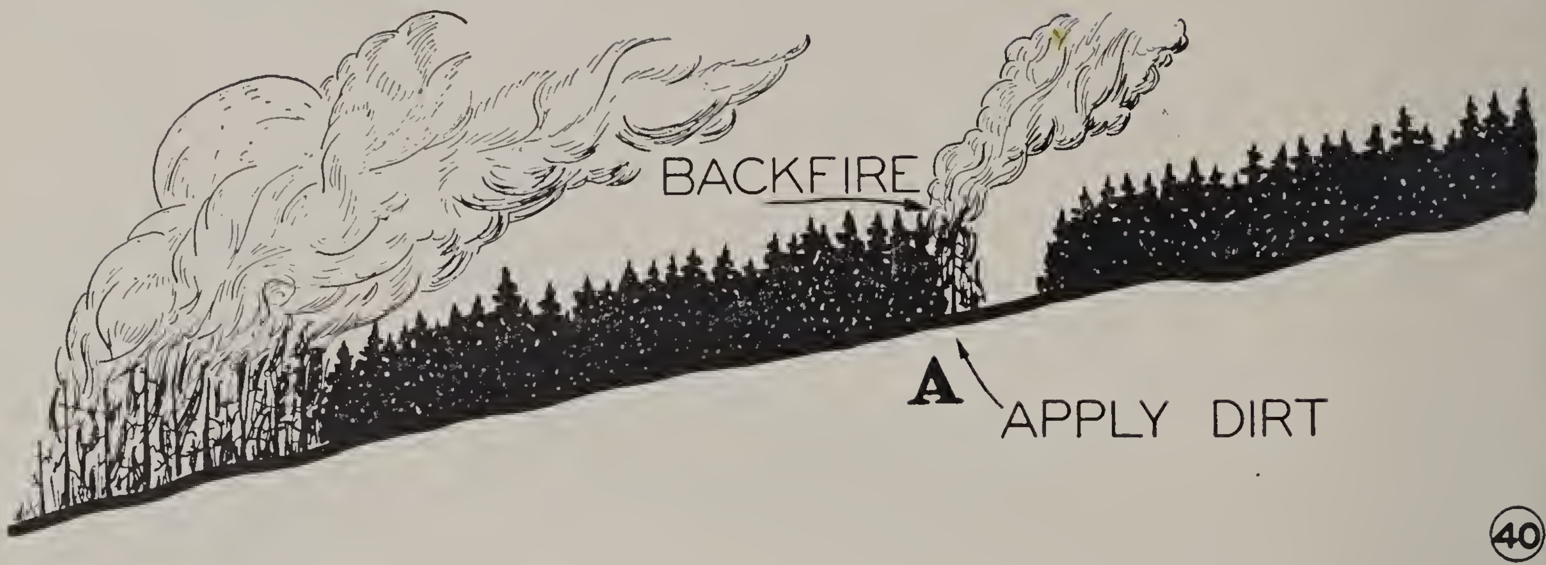
Wet down area outside of line as backfire is set.

Why:

To prevent spot fires or flaring over line.

Problem 6

How to Use Dirt in Backfiring:



Condition:

Backfiring against wind from narrow line in reproduction, brush or grass cover.

Action Required:

Use dirt or water to decrease intensity of backfire near line until backfire burns well away from line, or until draft pulls backfire in.

Why:

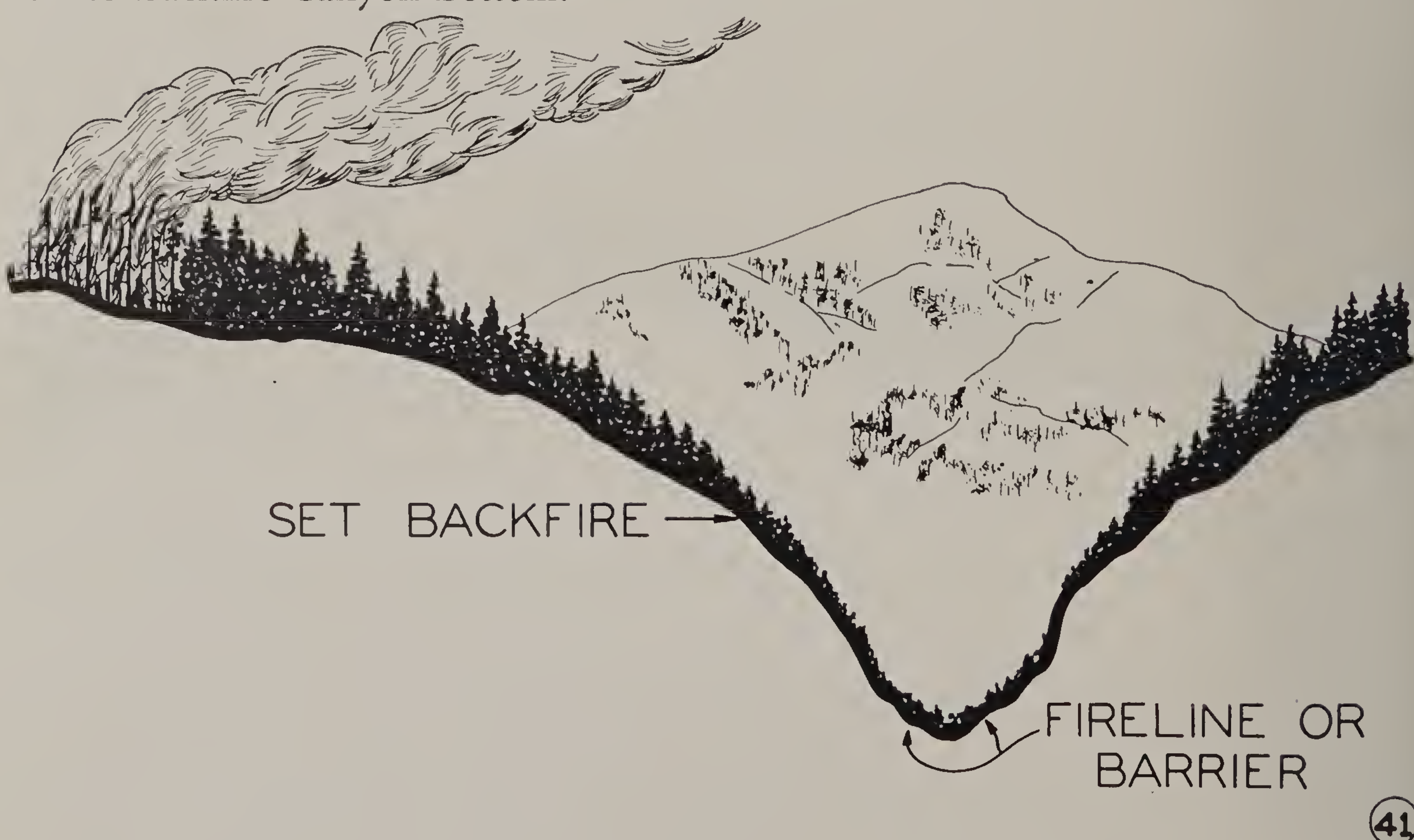
To reduce possibility of backfire becoming too hot, driving crew out and fire spotting or flaring over line.

Supplemental:

Same problem whenever backfiring must be done from a line too narrow to assure that fire will not cross.

Problem 7

How to Backfire Canyon Bottom:



Condition:

Canyon bottom line, where no readily inflammable material exists along the lower edge of the slope. (Desired to use bottom on account of rolling material from high up on slope.)

Action Required:

Set the backfire up the slope in good fuel above the line or barrier. It is often advisable to go up a short distance into the inflammable material, allowing the backfire to burn down as well as upward.

Why:

To insure rapid and clean burn by backfire; to reduce the threat of spot fires across the canyon by allowing backfire to burn down as well as up.

Problem 8

Emergency Backfiring of a Line Not Completed to Planned Terminus:

Condition:

Line being constructed up a hill in advance of fire with plan of backfiring down as soon as line is completed. Onrushing fire does not give time enough to complete line.

Action Required:

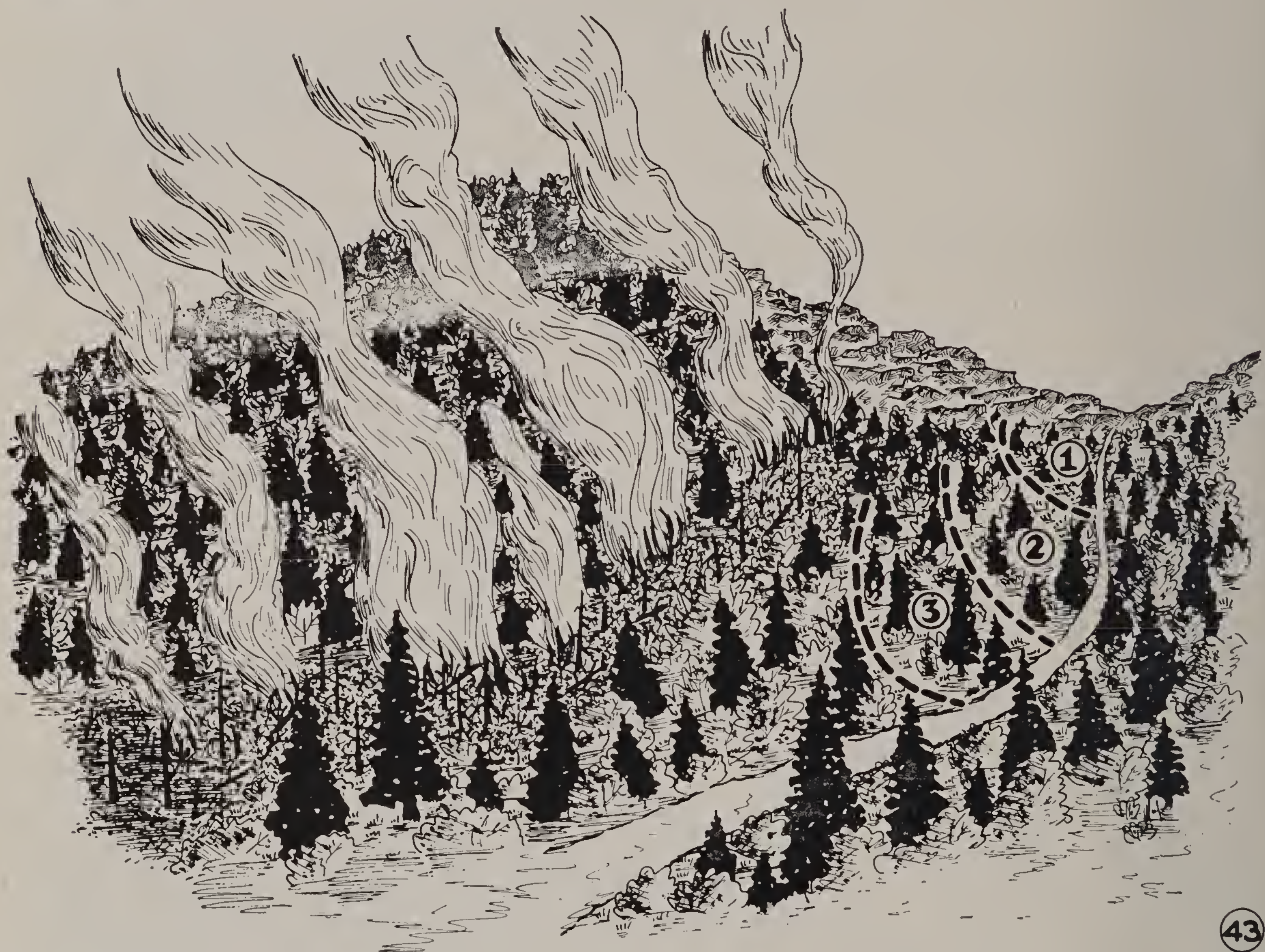
Starting backfire at top of completed section of line and carrying it down against onrushing fire.

Why:

If successful, that portion of line already built will be saved, thus narrowing down the area of spread of the fire. This is another "desperation" tactic and must be used only by highly skilled firemen and only on larger fires. It is dangerous practice but may be necessary under certain unusual conditions.

PROBLEM 9

How to Carry Backfire From Top to Bottom of Slope Under Severe Burning Conditions:



Condition:

Wind up moderately steep slope, quartering to top. Fire edge farthest advanced at top; moderate rate of spread. Burning conditions favorable to backfire taking hold. Backfire line already constructed. Fuel uniform. Mixed conifer type.

Action Required:

Start at top of ridge and carry backfire downhill to canyon bottom, letting one stretch of backfire burn well in toward main fire before setting next section of backfire.

Why:

Main fire is farthest advanced at top and stands best chance of crossing control line near top of slope. Backfire does not have chance to gather headway and make a big front with attendant danger of sweeping over line. Backfire as gradually carried down will burn back up to already burned area with no danger of getting over top of hill or over the line.

How to Backfire Under Unusually Poor Burning Conditions:

Condition:

Main fire has died down. Poor burning conditions. Wind gentle, down-slope draft. Moderately steep slope. Medium fuel type. Not possible to complete control by direct attack before next burning period with man power available.

Action Required:

Start backfire at lower end of line and let it spread uphill into the area to be burned out.

Why:

To allow the backfire to gather headway due to uphill run, to develop enough heat and draft to neutralize unfavorable burning conditions and to obtain a good burn. A tricky practice, requiring careful handling. Use only when other practices appear wholly unsatisfactory.

How to Backfire a Ridge Top Line Joining Two High Peaks With a Deep Saddle Between:

Condition:

Any fuel. Burning conditions favorable. Wind favorable. Backfiring has reached point A.

Action Required:

Continue slowly with backfiring from point A, sending part of crew to point C. Backfire from point C toward saddle, reaching saddle at B at approximately same time as backfire from A. At same time, backfire slowly to the left from C or hold with a check line. Proceed very cautiously when crossing saddle since temporary adverse wind condition may be set up by backfire.

Why:

If the crew had proceeded from point A to point C with the backfire, the fire might escape due to uphill run from B to C.

Supplemental:

The same method should be used to cross deep canyons or ravines with a backfire.

Use of Buffer Lines in Backfiring:

Condition:

Fast spreading fire on lower end of long, broad slope. Medium to heavy fuels. Fire too hot to attack by direct method. No break in fuels and no barriers.

Action Required:

Build and backfire indirect line sufficiently in advance to permit firing out to safe distance. Build and fire series of buffer lines in advance of firehead.

Why:

Buffer strips of temporary, flimsy construction can be quickly built and fired. If correctly located, will tend to slow down head of fire before it strikes backfire along main line.

Good Practices in Backfiring Developed by Problems:

1. Properly located lines simplify the problems in backfiring. Problem 1.
2. Utilize promptly favorable weather conditions for backfiring. Problem 2.
3. Backfiring is often a highly specialized work of great difficulty, so the best special tools available should be supplied for it. Problem 3.
4. In tight situations, time setting of backfire to utilize draft from main fire. Problem 4.
5. Under adverse conditions, use dirt or water as aids in holding backfire. Problems 5 and 6.
6. Adapt backfiring practices to special topographic conditions. Problems 7 and 11.

7. Chances must be taken frequently in backfiring under very adverse conditions. Problems 8 and 10.
8. Backfiring operations should usually proceed downhill; backfires should burn uphill. Under poor burning conditions it may be necessary to start them from the lower portions of the line and proceed uphill. Problems 7 and 9.

MOP-UP

As defined in the glossary, mop-up is the work required to make a fire line safe after primary construction work is completed. A certain amount of mop-up is an integral part of construction and, while carried on simultaneously with line building, it becomes an independent phase of firefighting, as soon as the spread of the fire is stopped. Ordinarily mop-up comprises but two actions—putting fire out and disposing of fuels, the object being to prevent the fire from crossing the fire line.

WHAT TO DO ON MOP-UP ON ALL FIRES

1. Start work on each portion of line just as soon as possible after line construction is completed.
2. Put all rolling fuel into such a position it cannot roll across lines.
3. Spread, rather than bury, smoldering fuel that cannot be put out.
4. Allow fuel to burn up if it will do so promptly and safely, or use water or dirt to put out as much fire as possible.
5. Eliminate promptly all special threats, such as snags, rotten logs, stumps and singed brush and trees inside.
6. Search for burning roots that may carry fire under control lines.
7. Fall snags if they are threats.
8. On small fires, all fire should be extinguished in the mop-up, where quantities of burning material are not so large as to make this obviously impracticable.
9. On large fire, mop up completely enough of the area adjacent to the line to be certain that no fire can blow, spot or roll over the fire line under the worst possible conditions.
10. Search for smoldering spot fires ahead of the fire.

PROBLEMS IN MOP-UP

PROBLEM 1

How to Dispose of Small Material Burning Near Fire Line:

Condition:

Such large quantities of fuel as to make it impracticable to extinguish all fuel burning or smoldering near line.

Action Required:

Scatter fuel well back from line into burned area.

Why:

To decrease possibility of spotting or blowing over by removing burning material adjacent to line and allowing it to burn up.

Problem 2

How to Dispose of Highly Hazardous Fuels Outside of But Adjacent to Fire Line:

Condition:

Snags inside burning and possibility of spotting into punky wood and masses of slash just outside of hot fire line. Snags cannot be felled for some time.

Action Required:

Remove fuels to safer distance. If not possible to move, cover with thin layer of dirt.

Why:

To remove or treat fuels apt to act as hosts to spot fires.

Problem 3

How to Prevent Fire Creeping Through Roots Under Fire Line:

Condition:

Roots burning inside of and extending under fire line.

Action Required:

Uncover and remove burning portions of root. Each punky stump near line should be investigated even though no smoke is seen.

Why:

To prevent fire burning under ground and coming up in unburned territory.

Disposal of Burning Snags:

Condition (a):

Snags burning inside and near the line with fire above reach of men.

Action Required:

Fell snag away from line into burn if lean permits. To provide standing room for falling, shovel away hot material from base or cover with dirt. Scrape, cut out or extinguish with water all burning portions of the snag. Falling limbs or burned-off top likely to drop anytime. Dangerous—constant watch necessary.

Supplemental:

If lean of snag does not permit snag to be felled in burn, a space should be cleared where the snag will fall or may roll or slide.

Condition (b):

Snags burning in base only.

Action Required:

Knock down blaze with dirt or water; chop or scrape out burning portion with axe, pulaski or shovel; peel off loose bark as high as can be reached; apply dirt or water to cracks to extinguish any sparks which might be smoldering; scatter the material removed from snag in burned-over area; if this consists of larger material it should be buried completely or otherwise made safe. Any work done on burning snags is extremely dangerous since limbs, chunks of the trunk and even the top of the snag itself often are burned off and drop without warning.

Problem 5

How to Handle Log Piles Burning Near the Fire Line:

Condition:

Logs dangerously close to line.

Action Required:

If logs are movable, separate and let them burn out. Move to lie up and down slope and trench lower end where necessary, to prevent embers from rolling into unburned area.

Why:

To reduce heat and thereby decrease possibility of spotting. To prevent rolling embers when steep slopes are involved.

Supplemental:

If logs don't endanger line or cannot roll, leave them in piles to burn out if that method of disposal is safe and quicker than putting fire out.

How to Place Movable, Burning Log So it Will Not Roll:

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Condition:

Burning log lying with contour of slope.

Action Required:

Move log to lie up and down slope. Trench around lower end to catch rolling embers.

Why:

To prevent logs and live embers rolling into unburned territory.

Supplemental:

If a log is too large to handle, cut to sizes that can be moved and proceed as above. If log is too hot to cut, block with rock or earth and trench along lower side of log to catch rolling embers and the log itself.

How to Handle Burning Stumps:

Condition:

A controlled fire on a steep slope has large burning stumps that should be allowed to burn up but which may result in live embers rolling down over the undercut fire line on the lower edge of the fire.

Action Required:

Construct a trench close to and on the down-hill side of the stump, to catch the burning embers. (On small fire where time is available, action should be taken to extinguish fire.)

Why:

To prevent burning embers from rolling and possibly going over trenched fire line. Placing the trench close to the stump makes it more effective. Rolling chunks are thereby not permitted to gain momentum which would cause them to bounce over main line.

PROBLEM 8

How to Dispose of Chunks and Similar Fuels:

Condition:

Many burning chunks, etc., on moderate or steep slope; may roll over trenched line. Too numerous to put out in time available.

Action Required:

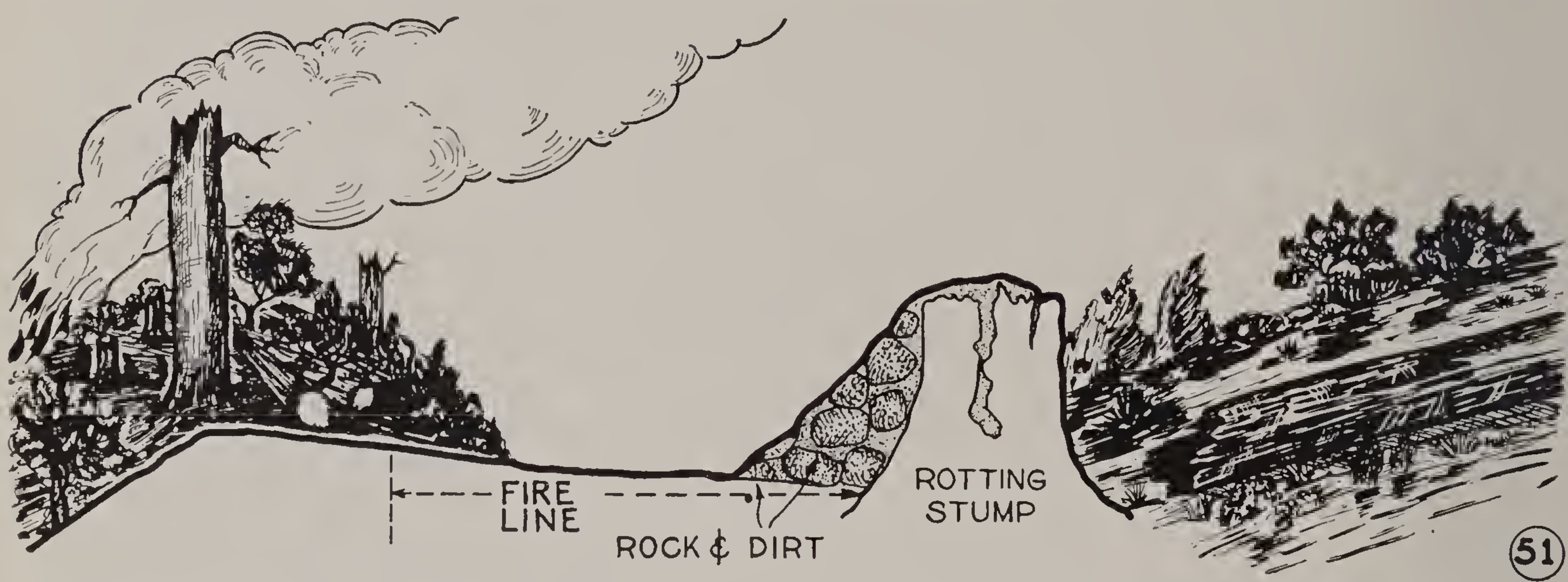
Construct trenches (beds) along slope in burn, long enough to hold the chunks. Place chunks in trenches; don't bury.

Why:

To allow chunks to burn out without danger of rolling over lower fire line.

PROBLEM 9

How to Prevent Ignition of Stumps Outside But Close to Line:



Condition:

A stump outside or inside but near the fire line, opposite heavy burning material which must be allowed to burn out.

Action Required:

Scrape duff well from around stump. Build up a layer of earth on side of stump next to fire, using loose rocks to hold it in place if necessary. Cover top of stump with clean earth. If rocks are not available, use any material available and surface it with mineral soil. As an emergency measure where dirt is not available, lay *green* brush over stump temporarily to protect from sparks.

Why:

To prevent spot fires or direct ignition of stump.

Supplemental:

The same method can be used in protecting a cat face on a standing tree exposed to severe heat, sparks or flame.

Problem 10

How to Prevent Ignition of Log Outside But Adjacent to Fire Line:

Condition:

A dry, punky log too large to move extending away from hot place on fire line.

Action Required:

Cover end of log as in foregoing stump problem. Cover both sides and top of log with earth back as far as deemed necessary. Rest of log may be peeled if bark is principal hazard. A hard, smooth wood surface is much less receptive to sparks than dry bark or decayed material. Covering decayed spots with dirt may be effective. All debris should be moved back a safe distance.

Why:

To prevent spot fires or direct ignition of log.

Problem 11

How to Use the Hands in Mop-up (Feeling for Fire):

Condition:

A severe fire has burned over a small area that contained a fairly heavy stand of timber with considerable duff, a few patches of brush and some rotten logs. The fire appears to be out and no smoke can be seen.

Action Required:

Test all of the fire with hands; feel particularly in partly consumed duff, in incompletely burned litter and into the remains of punky logs. Dig out hot spots as discovered. Mix fire with dirt to extinguish. White, fluffy ashes usually indicate presence of fire.

Why:

To locate smoldering fire which cannot be seen.

PROBLEM 12

How Water Can Be Used Effectively in Mop-up:

Condition:

Fire has burned on steep slope with vertical rise from bottom to top of one thousand feet.

Action Required:

If pumper is available, assign crew, including competent operator, to operate the pump from creek; put out burning fuel far enough back from the line so that sparks cannot blow into unburned territory, or chunks roll into it. Crew should go over the area methodically, turning chunks and small logs over and over to be certain that all burning portions are put out. Pump crew should go as far up each flank line as the pumper can reach.

Back-pack crews with hand pumps should follow the same plan in the area not covered by the pumpers, until the entire danger zone has been thoroughly worked. If there are very heavy accumulations of heavy fuel burning hard close to the lines, they should be cooled down first with water to reduce the danger of loss of line. Occasional return visits should be made to be sure no sparks have been left in the mopped-up area.

Why:

Water is the most effective natural agent known for extinguishing fires. If properly and skillfully used, it will complete a job of mop-up much more rapidly than this can be done by any other means.

Supplemental:

In large fires it is usually unnecessary to work over the entire area with water. Small fires can best be drowned out completely with water, if this is available within practical delivery limits, to save mop-up work and to relieve the men sooner for other fire duty.

PROBLEM 13

How to Make Safe Partially Burned Clumps of Brush or Reproduction Close to the Lines (Prevention of Re-Burn):

Refer to sketch No. 13.

Condition:

A fire ran through area of brush or reproduction, close to the line but has merely dried it out without consuming the crowns.

Action Required:

To eliminate the threat before the heat of the next day:

1. If the amount is not too large, cut down and scatter away from the control line inside the burn in areas free from fire.

2. Use special firing equipment, such as torches and flame throwers, to burn out scorched crowns.
3. If the patches are too large to handle by methods 1 or 2, put out all surface fire within them and construct a good line between them and the rest of the fire.

Why:

To either remove fuel or isolate from possible ignition next day. Scorched crowns of brush or reproduction are particularly dangerous fuels; they ignite readily when daytime burning conditions prevail, and fire will flash over previously burned ground. The danger of spotting and flaring over adjacent lines is extreme.

Good Practices in Mop-up Developed by Problems:

1. Spread well inside of lines smoldering material that is not put out with water, rather than pile it up and cover with dirt. Problem 1.
2. Eliminate or put into safe condition adjacent outside fuel of great inflammability, such as rotten logs, snags. etc. Problems 2, 9 and 10.
3. Look for and dig out burning roots near control lines.
4. Separate masses of large fuel to reduce heat and danger of spotting. Problem 5.
5. Eliminate all snags inside of line that could, under most adverse weather conditions, throw sparks over lines or fall over them. Problem 4.
6. Put all rolling material into such a position it cannot possibly roll across the line. Problems 5, 6 and 8.
7. Place trenches immediately below all heavy material which might roll across line. Problems 6, 7 and 8.
8. Feel with hands for possibly smoldering spots. Problem 11.
9. Use water wherever possible in mop-up. Problem 12.
10. Do not leave partially burned clumps of brush or reproduction close to fire lines. Problem 13.
11. Use dirt to reduce heat, retard spotting and smother fire.

PATROL

While patrol is a necessary part of the line construction job, experience has proved that over-emphasis of the patrol job has caused much waste of valuable manpower. Except for certain situations which will be enumerated later in this chapter, patrol work in Region One will be considered a part of the mop-up job.

Patrol, as defined in fire suppression work, indicates the act of moving forth and back over control line during or after line construction to prevent breaks, discover spot fires and check on dangerous points. Much of this type of service may and should be a part of the mop-up crew's duty. Patrolmen, as such, should be assigned where circumstances warrant use of a man or crew strictly for observation purposes. These instances ordinarily would include the following:

1. Immediately following the setting of backfires.
2. On line adjacent to dangerous snags likely to throw spot fires, but too hot to fall.
3. On line below fire on slopes where rolling embers are likely to cross line from far inside.
4. To guard against breaks where heavy fuel bodies are left to burn out inside.
5. To maintain watch for spot fires in spark-strewn areas outside line.
6. To provide detection service along lines when incendiarism is likely.

Things to Do in Lining Up Patrol:

1. Designate definite beats for each patrolman. Mark ends of beat with signs or blazes.
2. Arrange for communication or signals between patrolmen.
3. Systematize and synchronize schedule of beats so patrolmen do not get together for gab-fests.
4. Provide supervision if patrolmen are of unknown or questionable dependability.
5. Have patrolmen work on dangerous spots as well as to watch them.

METHODS FOR CONTROLLING FIRES

After a fire covers more than a mere spot, efforts at suppression are at first confined to a narrow strip around its outer margin. The main objects are, first, to stop its spreading, then to make it absolutely safe.

The usual procedure is:

1. To knock down or check blazing frontages, including the falling or quieting down of dangerous snags, stubs or other materials which are getting spot fires.
2. To literally cut off the extreme outer edge from access to new fuel by trenching, by building a line and backfiring or by literally extinguishing with water or mineral soil.
3. To put out or allow major portion of interior materials to burn themselves out.
4. To mop up or literally extinguish all persistent fires on the entire area or at least a wide marginal belt.

For accomplishing this, there are four methods of attack, hereafter referred to as the Direct Method, the Two-Foot Method, the Parallel Method and the Indirect Method. Briefly summarizing these, it may be said that:

1. The Direct Method is a spade method and consists of scraping in, shoveling in or digging out and throwing in the burning edge of the fire. (Would also include actual extinguishing of edge with water or by whipping.)
2. The Two-Foot Method is a substitute for the Direct Method where hoes, mattocks or plows are used in constructing a line not over two feet from the burning edge so as to leave as little material as possible for smoldering.
3. The Parallel Method consists of constructing a continuous trail with hand tools or plows from 2 to 50 feet in advance of fire and immediately burning out intervening strip.
4. The Indirect Method consists of completing a continuous line at a considerable distance in advance of the fire and then backfiring.

The choice between them depends chiefly on:

Condition of the fire edge at time of attack.
Probable changes in fire as day advances.
Probable effectiveness and controllability of backfire.
Topography and natural fire breaks.
Menace from snags and crown fires.
Relative amount of labor required and available.

It must be clearly understood that methods are not selected for the fire front as a whole but to meet existing conditions on each small sector. Not only do differing sectors require different methods, but even the same sector requires different treatment at different hours of the day. For example, on a large fire we might start early in the morning by applying the Direct Method on the first three sectors, then for a stretch of 100 yards find the Parallel Method most useful, then the Two-Foot Method, etc. Frequently all four will be used.

DIRECT METHOD

This method consists of applying work directly on perimeter or extreme edge of fire. In other words, the fire line in this case is the same as the natural edge of fire. It is composed of stretches of front which either have gone out naturally, been extinguished, or from which all smoldering material has been dug out and thrown on burned-over ground.

The work usually consists of:

1. Swamping out enough to facilitate work.
2. Cutting off logs and poles at a point at least two feet in advance of fire edge and throwing all charred wood on burned area.
3. Scraping in, shoveling in, or digging out and throwing in, all smoldering or burning debris, needles, matted duff or humus.
4. Falling and extinguishing all dangerous snags within 100 or 300 or more yards inside the line, which hold fire or might throw sparks across.
5. Extinguishing all surface or ground fires within 40 to 80 feet or more of line.
6. Burning off at night or in early a.m., any tree moss inside lines which might catch and carry fire into crowns during heat of day.
7. Maintaining vigilant patrol to hunt for spots of fire smoldering on outer edge of line or cut.
8. Actually running hand through ashes on extreme edge before skipping stretches which are apparently extinct.

Tools:

A shovel is generally the best tool to use with this method as all material must be thrown in. With pulaski, grub hoe or mattock a man has to stand on burned ground to drag material in and there is also danger of "flipping" twigs by the sharp blows struck with such tools.

Advantages of Direct Method:

These may be summarized as follows:

1. It takes advantage of all stretches which have gone out through lack of material or changed burning conditions due to dying down of wind, light rains or natural moisture of material which front has reached.
2. It immediately robs fire of all new material, thus reducing to a minimum the going out period.
3. It gives fire no opportunity to gain greater momentum.
4. It frequently eliminates large part of danger from crown fires, because either crowns and tree moss inside line have already been consumed, or the remaining material, which might cause a sufficient volume of heat to carry flame into tops, will burn itself out in an hour or two.
5. It saves time and expense of backfiring.

6. It eliminates the uncertain elements involved in all backfires:
   (a) As to ability to control them.
   (b) As to ability to make them burn clean after fire trail is constructed.
7. It does not involve the sacrifice of additional timber and tends to hold fire down to minimum acreage.

Disadvantages of Direct Method:

1. It is not applicable on an intensely hot fire as heat and smoke make work prohibitive.
2. It usually results in a more irregular and, therefore, longer line than either the Parallel or Indirect Methods (although by taking advantage of stretches which have gone out and not having to backfire, total amount of labor required may be much less).
3. It makes patrol work more difficult than where a continuous trail has been built.
4. It is especially hard to supervise, i.e., to secure a thorough job without doing unnecessary work. It is not a cut and dried proposition of building a trail and backfiring. Each man becomes responsible for digging out all the fire smoldering along the edge of a given sector.
5. There is considerable danger that some workman will overlook or leave fire smoldering on the outer margin of line so that a vigilant patrol for picking up such spots must be maintained for several days.

When and Where to Use Direct Method:

As a general rule: On smoldering sectors, i.e., whenever fire can be caught in the smoldering stage. In special cases on weakly blazing fires when flames can be easily beaten out or smothered.

The Direct Method is particularly recommended:

1. In all types including old burns, whenever considerable stretches of front are extinct so that digging out a few smoldering spots will result in gaining long stretches of dead line. Often this condition prevails in the early morning.
2. On typical duff fires.
3. Where there will be difficulty or a long lapse of time in securing a clean burn with backfires.
4. Wherever it would be particularly hard to control backfires on account of adverse winds, large front or excessive amount of debris and snags.
5. On steep hillsides above the fire so as not to let it get any start.
6. Where there is special danger of fire going into crowns in heat of day. (If possible it should always be used where trunks of trees are covered with moss.)
7. Whenever standing snags inside line will be pretty well burned out before heat of day or cooled down around their bases so that they may be felled. (Backfiring from a distance would necessitate falling all intervening snags, or incur risk of their burning fiercely during heat of day.)

THE TWO-FOOT METHOD

This is a substitute for the Direct Method permitting the use of grub hoes, pulaskis, mattocks, trenchers or plows without danger of scattering embers. It consists of constructing a trail not over two feet from the edge of the fire, the object being to leave just as little material as possible to smolder. It differs from the Direct Method in that it leaves a ridge of duff to smolder out. It differs from the Parallel Method in that backfiring is not contemplated. If fire persists without burning to line, it becomes a part of the method either to shovel all intervening litter or duff onto the burned area or to dig out smoldering spots as in Direct Method. This possible additional work must always be taken into account in selecting and applying this system.

Abuse of this method by locating lines several feet in advance when conditions are such that material may smolder for days or weeks, is one of the serious and costly errors often made in firefighting.

In applying method the work consists of:

1. Swamping out enough to facilitate trail work.
2. Cutting out logs as in Direct Method.
3. Digging a trail from 6 to 24 inches wide and down to mineral soil (material in this case should be thrown to outer edge of line).
4. Falling snags, mopping up ground fires and burning off tree moss as in Direct Method.
5. Maintaining patrol to detect spot fires across line and to hasten final clean-up by shoveling in duff which holds fire but is not burning clean to line.

Advantages of Two-Foot Method:

1. Trail can frequently be constructed more rapidly than edge can be dug out.
2. It simplifies supervision, eliminates danger of leaving fire on outer edge and facilitates patrol by providing trail.
3. Crew can instantly swing to Direct Method when edge is extinct or fire can be dug out to better advantage.

Disadvantages of Two-Foot Method:

1. It fails to immediately rob fire of all new fuel and leaves a 6 to 24 inch strip of duff which may smolder or hold fire for anywhere from an hour to a week or more.
2. There is the very common danger that line will be constructed too far in advance of fire, thus leaving more material to smolder.
3. Increased duration of patrol and subsequent work of digging out fires for final clean-up frequently result in more work than Direct Method would have involved.
4. Trail gives false sense of security. There is more danger of fires escaping through sparks blowing across trail during protracted burning out period than there is of the patrolman's failure to find and dig out spots on outer edge of cut in Direct Method.
5. There is element of risk that crew may throw some embers to outside of line with debris.

When and Where to Use Two-Foot Method:

This method should be confined to sectors where fire is smoldering in heavy duff, its edge cannot be dug out with hoe or mattock and clean burning with backfires is difficult or impossible.

PARALLEL METHOD

This method consists of constructing a continuous fire line or trail from 6 to 50 feet in advance of the fire and immediately burning out intervening material. (Where it is only a matter of five or ten minutes, the main fire may sometimes be allowed to burn to the edge of the line. Even in these cases it is usually safer and better to backfire, since back draft is favorable and there is less danger from sparks.)

In this method, the basic principle is to stick fairly close to the edge of the fire, but latitude is allowed for dropping back enough to avoid intense heat, to cut straight across deep indentations of the fire front to save labor provided all material inside the "cut off" can be quickly and safely burned out with backfires and to straighten or shorten line, drop back from snags, encompass burning logs or improve location. Generally speaking, it should never be over 50 feet from fire, usually not over 8 to 10 feet. It differs from the Direct and Two-Foot Methods in that a continuous trail is built and backfire used. It differs from the Indirect Method in that it sticks close to the fire regardless of topography and natural firebreaks and forces issue as line is built.

The work consists of:

1. Swamping out second growth and brush on strip 4 to 10 feet wide, depending on inflammability of material and wind.
2. Cutting out as wide sections of logs as can be easily handled and rolling them to outer edge of line.
3. Scraping off all light debris and branches to inside of line, where they will be an assistance in backfiring unless so doing will create too much heat and flame. Then throw outside.
4. Constructing a continuous trail or trench dug down to mineral soil and made from 1 to 2 feet wide.
5. Falling all snags which scatter fire across line or threaten to. (Snags on unburned strip may sometimes be kept from catching fire by tearing off bark and removing inflammable material from around bases, otherwise they should usually be felled before backfiring.)
6. Immediately backfiring intervening strip of unburned material.
7. Falling snags and mopping up as with previous methods.
8. Maintaining adequate mop-up and patrol until all material inside line is burned out or extinct.

Advantages of Parallel Method:

1. It can be used in front of hot fires.
2. It simplifies supervision, eliminates danger of leaving fire on outer edge and facilitates patrol by providing trail.
3. Working with grub hoe, mattocks, trenchers or plows in matted needles, duff or sod, a trail can usually be constructed faster than the edge of a fire can be dug out with a shovel.

4. It permits cutting across indentations and shortening line, encompassing logs, etc.
5. It is adapted to use of plows, trenchers, etc.

In comparison with Indirect Method:

1. On account of the narrowness of intervening strip, backfiring is comparatively much easier to control and may follow along with line construction work thus forcing the issue while crew is near at hand and before a large amount of work has been expended on a line that may not hold.
2. Volume of heat and danger from backfires is usually much less.
3. Can easily be changed to Direct Method if fires die down.
4. Area of burn is held to smaller acreage.
5. Back drafts are stronger.
6. Crew is safer as they can see what is happening and get through onto burned out ground in an emergency.

Disadvantages of Parallel Method:

1. It fails to take advantage of portions of the fire edge which may have gone out and necessitates re-establishing a solid front of fire.
2. It is subject to the great danger, especially in green timber or light fuel types, that backfires will not burn when desired. (Inability to clean out the intervening strip would mean a long smoldering period lasting for days or even weeks and during which the fire can never be considered safe. Such a condition usually compels digging out both backfires and main fire.)
3. It contains elements of danger in that backfires may get beyond control, set new snags which will burn during heat of day or start a crown fire.
4. It delays the issue. Frequently the labor involved in setting backfires and waiting for them to burn out more than offsets any saving through ease of construction or shortening of line.

When and Where to Use Parallel Method:

1. As a general rule: On sectors where fire is burning briskly or is too hot to check by direct attack.
2. In special cases: Where fires are smoldering on a large percentage of the front but conditions for backfiring either are now or soon will be exceptionally good, and use of method will result in saving time. These may include:
   (a) Sectors where litter can be ignited as it lies and will burn out quickly without special danger of crown fires. (Yellow pine type offers best example.)
   (b) Steep slopes below the fire.
   (c) Sectors where line can be shortened by making cut-offs.

Never use the Parallel Method if there is any danger of inability to burn out all intervening material and making fires burn clean to edge of fire line.

THE INDIRECT METHOD

This method consists of locating the fire along favorable breaks in topography or natural fire breaks and backfiring the intervening strip. This usually involves dropping back a considerable distance from the fire front and burning out a wide strip of country.

Construction work and treatment of snags is the same as in the Parallel Method, except insofar as streams, roads, etc., obviate necessity of line construction, and flattening of topography eliminates danger of roll. Backfiring, however, cannot follow close on heels of construction crew and usually must be delayed until line across entire side of fire is completed.

Advantages of Indirect Method:

1. Crew is not troubled by heat or smoke from main fire, so that it can be used in front of any fire regardless of intensity or rapidity of advance.
2. It permits taking advantage of favorable breaks in topography such as benches, tops of ridges and bottoms of slopes and of natural fire breaks as streams, changes in fuel types, rock slides, swamps, meadows, clearings, roads, trails, etc.
3. It permits locating the line straight up and down steep slopes so as to avoid excessive danger from rolling embers.
4. It may reduce total amount of line needed and often results in easier construction through selection of more open country.

Disadvantages of Indirect Method:

1. It fails to take any advantage of portions of the fire front which may have gone out and necessitates re-establishing a solid front of fire and igniting a new set of snags.
2. It is subject to the danger that backfires cannot be made to burn after line is completed. In such an event the labor is practically wasted. If the fire ever burns up to the line, it will come when burning conditions are favorable. Then breaks in topography, streams or other natural fire breaks may stop it, but a narrow fire line will seldom hold.
3. Large blocks or whole sides must often be burned out at one time. The immense volume of heat and momentum attained by any fire used in burning out a wide strip of country is dangerous. It always has a chance to get away on three sides and may on the fourth side if its front becomes larger than face of main fire.
4. It delays issue. Lines must usually be completed before backfiring begins; therefore, if lost, a maximum amount of work is wasted. Errors in estimating time necessary to complete work may result in main fire hitting line before it is backfired. Changes in burning conditions of main fire may result in its getting into a state where some other method would become much more advantageous. This would necessitate duplication or extra work.
5. A line lost along a stream or bottom of a draw means that fire has gained foothold on another uphill slope. With Direct or Parallel Methods, the natural fire breaks remain as a second line of defense.
6. It materially increases area of burn.
7. It is the most dangerous of all methods in that crew cannot see what is happening and may not be able to get away from crown fires.

When and Where to Use Indirect Method:

The Indirect Method is an emergency method and should be used only in rare cases. Burning out a wide strip of country is usually either a very difficult or a very dangerous task, especially in heavy fuel types. The feasibility of the method hinges

to a very large extent on the width of strip to be burned; character and condition of intervening material; and the nature, width or degree of protection offered by the natural fire break.

As a general rule, it should not be used unless lines and backfiring can be completed before heat of coming day.

Certain special conditions under which it may be used are:

1. When natural fire break is very close to edge of fire. (Practically speaking there are no fire breaks which can be absolutely counted on to stop intensely hot fires. Everything depends on condition of fire and weather factors prevailing at time it hits the break. This is a gamble. Lakes and the largest rivers in Region One have failed to stop fire when conditions were critical.)
2. When excessive amount of roll makes it practically impossible to stop spread of fire without dropping back to more level ground, or running the line straight up and down the slope.
3. When the natural fire break is of such width or character that very little or no work will be required to insure its preventing escape of backfires.
4. When lines can be completed and a good job of firing out completed before the peak of the day's burning conditions makes such action dangerous.
5. When, after careful consideration, no other method of attack offers as good chance of successful control.

REVIEW QUESTIONS FOR SECTION II

GENERAL INSTRUCTIONS

1. In what three ways may a forest employee promote safer use of fire by forest visitors?
2. What smoking restrictions are in effect on this forest at this time?
3. What are the rules governing disposal of stove ashes?
4. What rules govern burning of rubbish or debris at guard stations?
5. What is meant by "false smokes"?
6. What is the order of report action when a fire is discovered by a lookout?
7. What reports, in addition to original lookout fire report, are required from lookout men for going fires?
8. When will a fireman go to fires outside his district?
9. State procedure to be followed by firemen and patrolmen in receiving order to go to a fire.
10. What should fireman do when he discovers a fire within his district and is unable to report to dispatcher or another station?
11. What responsibilities do forest permittees have in fire control work?
12. What is meant by "cooperators" in fire control work?

SUPPRESSION OF FIRES

FIRE BEHAVIOR

1. What are the three ways of stopping fires?
2. What are the three major factors which determine rate of spread and fire behavior?
3. Name four fuel factors which materially influence the rate of spread.
4. List the three weather elements which most affect fire behavior.
5. What effect does wind have on fires? Name five.
6. In what way does slope influence spread of fire? Name three.
7. What topographic position is normally most severe from standpoint of fire danger; bottom of slope, midway or top?

FIRST ATTACK

1. Why is it necessary to see the entire edge of a small fire before beginning work?
2. How does fireman determine point of first attack?
3. Name two most important dangers in snag fires.
4. What is basis for determining point of first attack when fire in canyon bottom is just getting under way on both sides?
5. Why is it sometimes necessary to move logs which are well inside before completing the fire line?
6. When is it good practice to build scratch (make-shift) line in first attack?
7. What factors determine whether line should be built against fire edge or some distance farther away from fire edge?
8. What should be done with islands of unburned fuel or scorched brush and reproduction inside the fire line?
9. What factors determine which of three or more fires should be attacked first when there are but two men available?
10. When should the smokechaser consider the fire too big for him and return for help?

11. What factors determine whether a fireman should spend his first effort in protecting buildings or in work to keep fire from forest materials?
12. How are fires in slide rock patches handled?

LINE LOCATION

1. What factors determine how far ahead of a fire the line should be located?
2. Where should line be located on fires having long fingers or necks?
3. Where should line be located on lower side of a fire on very steep slope when that edge is relatively near canyon bottom? Why?
4. When line must be located along bottom of steep-sided canyon, where should it be built? On side next to fire, on very bottom or on side away from fire? Why?
5. How do bodies of heavy fuel, snag clusters, etc., influence the location of line?
6. Where should line ordinarily be located on a fire spreading fast in slash or old burn when head is approaching large body of heavy green timber?
7. Where should line ordinarily be located if fire is burning in green timber and nearing edge of old burn or other type of high spread or higher resistance fuels?
8. Where is line located when burning snags inside are too hot to cut down?
9. Where should line be located on small fire just getting hold in high spread fuels, slash, etc.?
10. How should line be located to control narrow head of fire spreading rapidly up long, steep slope of unbroken fuel?
11. How should line be located to stop head of fire moving forward on wide front and too hot for direct frontal attack?
12. In steep, narrow canyons, wind may be expected to make certain daily shifts in direction. How does this affect location of lines?

LINE CONSTRUCTION

1. When should inflammable material removed during line construction be placed inside the line?
2. If placed inside, what must be guarded against?
3. What must be done to safeguard line which has been cleared too narrow to assure holding?
4. What treatment is given highly inflammable fuels outside and adjacent to fire line?
5. How do lines built above a fire differ from those built below the fire on steep slopes?
6. How is trench built below fire on steep, rocky ground?
7. Where driveway, right-of-way or other cleared strip is used as fire line, should trench be built on side next to fire or away from fire?
8. Under what conditions should segments of temporary line be built? When is "stalling" advisable?
9. When should supplemental or alternate lines be built outside main line?
10. What work inside is ordinarily necessary as a part of line construction?

MOP-UP

1. What is meant by "mop-up"?
2. What treatment is given to heavy concentrations of smoldering fuels adjacent to and inside the fire line?
3. How should highly hazardous fuels outside, but adjacent to line, be treated when subject to ignition by sparks?
4. What is done to prevent fire from creeping under line in punky roots?
5. When fire in a snag close to line is above reach of fireman, what should be done? If snag leans toward burning area? If it leans out over fire line?

6. What is done with log piles or heavy masses of hot fuels burning dangerously close inside?
7. How may a log, burning too hotly to be immediately extinguished, be made safe on steep ground?
8. What may be done to safeguard stumps burning on steep ground which must be left to burn up?
9. What should be done with scorched brush and reproduction close to and inside fire line? (Crowns not yet burned.)
10. Name three ways in which dirt is used in mop-up.

SPECIAL LINE CONSTRUCTION METHODS

1. What is meant by "cold trailing"?
2. What seven dangers must be guarded against in "cold trailing"?
3. How does "hot spotting" differ from "cold trailing"?
4. Under what conditions can use of water alone be depended upon in lieu of control line?

BACKFIRE OR CLEAN-UP FIRE

1. When contemplating use of backfire along ridge top, where should line ordinarily be located; on side next to approaching fire, on crest of ridge or on opposite side? Why?
2. How may backfiring be stimulated when conditions are unfavorable for natural spread?
3. What influence does suction or draft of main fire usually have on backfires?
4. In what way may water and dirt be used to advantage in handling backfires?
5. On steep slopes or under severe burning conditions, should backfiring be carried from bottom to top or from top to bottom of line? Why?
6. When backfire line along ridge top dips through a saddle, what major difficulties must be guarded against?
7. What is meant by "buffer" line in backfiring?

PATROL

1. Name six conditions which justify assignment of a patrolman on the fire line.
2. What five things should always be done when lining up patrols?

METHODS FOR CONTROLLING FIRES

1. Define "Direct Method."
2. What are the most important advantages of the direct method?
3. On what type of fires should direct method seldom be used?
4. On what type of fires does direct method of attack offer greatest advantages?
5. How does "Two-Foot Method" differ from the direct method?
6. What are the advantages of the two-foot method?
7. What are the disadvantages of the two-foot method?
8. Under what specific conditions should two-foot method be used?
9. How does "Parallel Method" differ from two-foot method?
10. What are its advantages?
11. What are its disadvantages?
12. When and where should it be used?
13. Give definition of "Indirect Method"?
14. What are its advantages?
15. What are its disadvantages?
16. When and where should it be used?

Section III

SECTION III

SUPPRESSION OF LARGE FIRES

The national policy requires fast and energetic suppression of all fires in all national forest areas during possible dangerous fire weather. When immediate control is not thus attained, consider all elements of the situation and calculate the probabilities of spread, i.e., how much perimeter will the fire make and how much held line will be required to complete the job. Develop the organization to control the fire within the first work period. Failing in this, the attack for each succeeding day will be planned and executed with the aim of controlling the fire by not later than the beginning of the burning period the next morning. In any case not later than 10 a.m. No fixed rule can be given to meet every situation; the spirit implied in the policy will determine the action to be taken in doubtful situations.

PLANNING ATTACK

Suppression of fires can hardly be classed as an emergency undertaking under the present status of plans, preparedness and the regular occurrence of this job. It has become a more or less routine part of our work and should be so considered. We must think of fire suppression as an activity to be planned and conducted with the same degree of analytical calculation and cool-headed action that we would exercise in a big construction job. Such a conception of this work will do much from the psychological standpoint to reduce the unwarranted excitement, confusion and pressure which too often weakens our administration of fire suppression jobs.

In Region One we can expect to have a few large fires each year, due to large bodies of fast-spreading fuels and the normal frequency of lightning storms, during dry, windy weather. We are prepared for these fires so far as materials, machines and supplies are concerned. However, this wealth of equipment can be only as effective as the personnel directing and handling it. Success is dependent upon responsible men understanding the principles of conducting fire work and their knowledge of, or ability to, appraise fire behavior.

Over a long period of years certain principles and forms of organization have proved best. Certain tactics, strategies and techniques have been found more applicable than others, and at least a few of the indices for calculating spread of fire are now standardized. The purpose of this section of the Handbook is to define these approved elements of the suppression job that readers may benefit from the experience and knowledge of those men having had the most intimate association with Region One fire problems. No attempt is made to supplant experienced judgment with mechanical or mathematical formulas in planning and executing suppression work. The aim of this section is to set forth in orderly sequence the major steps in the suppression job that every man responsible for a part of the work may better understand his own assignments and those of his assistants and superiors. Uniformity of action and understanding will go far toward improving and harmonizing the performance of fire suppression personnel.

Once a fire has escaped initial attack, or will obviously attain a size requiring big fire organization, that is, more than smokechaser attack, the process by which attack is planned is generally by:

1. Calling on accumulated personal experience and knowledge of similar fires in the same or similar country. (Clearly, this method is useable only by men

with rich and extensive background for the existing conditions. Such fire-fighting is an art, not a science.)

2. Using the accumulated experience of others in the same manner as above when the dispatcher lacks background.
3. The attempt by men with both rich experience and analytical minds to estimate where the fire will be at the time they can get the major attack under way, and work back from there to determine location of camps and crews, strategy, location of line, etc. This process approaches a science within the limits of knowledge of the effects on fire behavior, of wind, slope, humidity and fuel and of unit output per man-hour of constructed and held line.
4. Dispatching forces and facilities obviously needed. Then check needs by means of mechanical dispatcher guide charts. Revise plan and supplement initial action if thus indicated.

The quality of planning first-period attack determines whether the fire will be held or lost, whether costs will be reasonable or otherwise and whether size will be held to a minimum.

The process has to be done rapidly, so that mobilization can proceed and the general attack can be begun as early as possible.

By no means are all the needed facts on fire behavior, rates of line building, etc., now known with enough accuracy so that attack can be planned as precisely as, for example, construction of a road. There are, however, guides, based on research and accumulated experience, which remove the steps in attack planning from the realm of guesswork or personal opinion.

It has seemed worthwhile to put down the successive steps in planning which are needed on all fires, together with the guides, in the form of generally applicable facts, which may be useful in individual cases. Obviously, we are a long way from reducing this complex and difficult process to a series of airtight formulas. The material cannot be used to solve directly the pressure problems that arise with each uncontrolled fire. But since the Region is committed to surveys and studies which will add greatly to the quantitative facts now available, it is important that at least the process of planning attack be systematized and generally understood. With such an understanding, the new facts can be effectively put to use as they become available.

THE PROBLEM IN GENERAL

There is an uncontrolled fire. Obviously it will require organization beyond a one-crew basis. It will take time—say until 6:00 p.m.—to mobilize and get an adequate organization on the line.

The dispatcher or fire boss needs to know first, where the fire will be at 6:00 p.m. and at later periods. All planning of strategy, total man-power needed and placing of crews and camps, starts from the appraisal of what suppression crews will be attacking then and at subsequent key periods, not on what the fire is now.

There is no simple rule to solve this problem, because the problem is always complex, with several important variables, and an exact proved formula for any one combination of variables does not exist. But an intelligent estimate is better than a wild guess, so an attempt to take advantage of what is known about fire behavior is always worthwhile.

The size of the job must be measured. The following questions must be an-

swered: What will the perimeter be? How many chains of line must be worked? How many men will it require to do this job in the time available? Where and how to attack?

GENERAL GUIDE FOR ESTIMATING FIRE BEHAVIOR

The behavior of fires will, in many instances, be so obvious that detailed consideration of individual factors or elements is not necessary. The fire surrounded by extremely slow spread fuels; a fire burning against barriers and those approaching certain topographic features may be adequately analyzed at a glance. However, the fires that usually bring disaster are those on which analysis of probabilities were not systematically or completely carried out. It is required that a record of "calculations of probabilities" be recorded as a part of the report on each fire on which 25 or more men are engaged. As a general guide or tickler list, the following paragraphs will stimulate consideration of major factors:

Slope:

Has effect similar to that of wind in accelerating spread. Increases difficulty of control in that sparks travel shorter distances to inflammable material in which to start spot fires. Burning embers roll over lines and fatigue factor increases when crews have to climb.

Wind:

Normally follows a daily trend or curve. Peaks in normal velocity can be predicted. See charts on following pages.

Humidity:

Daily characteristics follow normal trend. See charts.

Fuels:

Types of greatest spread under normal conditions: Cheat grass, slash, etc.; cutover lands; old burns with snags.

Time of Day:

Number of hours until normal shift in burning conditions. Air currents up canyon during day, down at night.

Weather Forecasts:

General forecast to determine whether night conditions will be normal. Whether next day will be better or worse than current day. Special forecast for this fire indicating number hours current conditions will remain substantially constant. Changes in wind, humidity, etc.

ELEMENTS OF FIRE BEHAVIOR

Regardless of whether the dispatcher uses experienced judgment or intricate formulas in calculating the behavior of a fire, he actually considers the same elements and factors. Almost subconsciously he combines these in his mental estimates. In the use of charts and meters he simply applies them in mathematical or mechanical form.

Those factors having greatest influence on fire behavior are divided into two major classes: "Constants," which can be accurately ascertained from available predetermined information and "Variables," which must be ascertained or estimated for individual cases as they occur.

Constant Factors (Information always available on fire maps):

1. *Fuels:*
   Character.
   Size.
   Continuity.
   Volume.
   Arrangement.
   Barriers.
2. *Topography:*
   Slope.
   Exposure.
   Character.
   Elevation.

Variable Factors (Must be calculated for each situation as it occurs):

1. *Wind:*
   Velocity.
   Direction.
   Duration.
2. *Fuel Moisture:*
   Small fuels ½ inch or less.
   Large fuels 2 inches plus.
   Precipitation previous.
   Humidity existing.
   Vegetative conditions.
3. *Time of Day:*
   Part of burning period through which fire will spread.
4. *Available time. Attacking Force:*
   Influence initial attacking force may have in reducing or restricting spread and size of fire.

Suggested Methods for Obtaining Timely Measurement of Factor Influences:

1. Fuel type map; observation by lookouts and personal knowledge.
2. Topography; maps, observations by lookouts and personal knowledge.
3. Wind; wind gauges in locality, estimates, forecasts.
4. Fuel moisture; estimate on basis nearest danger station ratings. Rain maps, humidity forecasts and general knowledge of vegetative conditions.
5. Time of day influence; personal knowledge of daily trend in burning conditions. Charts for sample localities showing daily curve of humidity, wind, etc.

CALCULATING MAN-POWER NEEDS

When the estimate of the fire's size is completed and converted into terms of perimeter length, the next step is to estimate the number of men required to affect control within the time objective. This necessitates consideration of those factors which determine the held line output per man-hour. Briefly described, these are:

1. *Fuel Resistance:*
   Size, volume, character and arrangement as affects held line output.
2. *Character of Crew and Supervisory Overhead:*
   Experience.
   Training.
   Adaptability.
3. *Size of Crew:*
   Recognition of fact that production decreases as size of crew increases.
4. *Fatigue:*
   Condition of crew upon arrival.
   Length of work shift
5. *Control Time Objective:*
   Length of attack period, or number of hours available in which to do a given number of man-hours of work.
6. *Method of Attack:*
   As it will influence size of fire or ultimate number of men required.
   Frontal or flanking.

The Region One Dispatcher's Guide Charts and Fire Spread Meter are provided only as a guide or check for calculation of probabilities and man-power needs. The mechanics of these charts involves values and formulas which cannot be supported by scientific facts or mathematical proof. Certain elements and values are derived from judgment estimates submitted by the most experienced field men and averaged for use in these charts.

These charts are not to be used as infallible indicators or meters, but instead are to be used to check the calculations and action after first dispatching is accomplished. When the dispatcher reaches the point where he wonders "Have I correctly sized up this situation?" or "Have I sent enough men?" he will use the charts to check his action. If his calculations differ with the results obtained by use of the charts, he will reconsider his action and act according to his best judgment.

Calculating Probabilities With Region Dispatcher Guide Charts:

1. *Ascertain danger class* from spread danger meter. Adjust actual measurements, secured from sources nearest to fire, by carefully comparing slope, exposure, timber stand (dense, average or open), exposure to wind, elevation, rainfall (recent and past), time of day, etc.

2. *Ascertain rate of spread factor* from Chart 1. Select proper danger class, in first column, then refer to proper rate of spread (fuel type) column, on same danger class line, and rate of spread factor will be indicated. Determine proper rate of spread (fuel type) by methods suggested under B 1, 2 and 4 above.

3. *Ascertain perimeter increase factors* from Chart 2. In first column select time of discovery of fire (to nearest preceding hour), thence across chart to proper arrival time and control time columns. Thereunder will be indicated the proper multipliers to be used in determining the probable *free burning* perimeters from discovery to arrival and from discovery to control time. The percentage of the difference between the arrival time perimeter and control time perimeter which should be allowed, depends entirely upon strength of attacking force and the method of attack anticipated. The arrival time perimeter plus the control period allowance equals total job size anticipated.

4. *Ascertain man-power needs* from Chart 3. Divide total chains of anticipated perimeter by the smokechaser output rate for the fuel type concerned. This gives the number of smokechaser hours of work to be done. In first column, select number of hours calculated in control period, follow this line to right until an output figure equal to number of hours of smokechaser work is found. At top of column will be shown number of men required to do the job, with allowance made for Factors A 5, 6, 7 and 8, as set forth above.

5. *Night Fires:* Between 9 p.m. and 9 a.m. Chart 2 may be used in the same manner as for daytime discoveries except for multipliers shown in column 2.

These are for daytime discoveries only and are applicable when a dispatcher desires to determine the probable perimeter of a fire which has escaped control throughout the first day. To determine job size for second morning control.

6. *Example:* August 7, normal slopes, normal humidity, 4-5 mile wind, 9% fuel moisture—Danger class 5. Fuel type is medium spread and medium resistance; discovery time is 10 a.m.; arrival time is 12 noon. Control objective is 2 p.m. Chart 1 gives a spread factor of 2.0. Chart 2 gives an arrival time multiplier of 3 and a control time multiplier of 10. Thus probable perimeter on arrival is 2.0 x 3 or 6 chains. Discovery to control time perimeter is 2.0 x 10 or 20 chains. 20 minus 6 is 14 chains or free burning increase during control period. If frontal attack is planned, 25% should be sufficient allowance. Thus 6 chains plus 25% of 14 chains equals 9.5 chains or probable total job size.

Conditions at Location of Fire	Moisture Content of Fuels ½" and Less						
WIND	Over 25%	19-25%	14-18%	11-13%	8-10%	5-7%	Under 5%
0-3 MPH							
4-7 MPH							
8-12 MPH							
13-18 MPH							
19-24 MPH							
Over 24 "							
	Spread Danger Class						

RATE OF SPREAD DANGER METER

Season and Slope Indicator ○

FRONT

INSTRUCTIONS

1. Pre & Post-Season--Set slide at (P) for fires before July 6 or after Sept. 10 if slope and exposure are normal.

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2. Mid-season--Set slide at (1) for fires during period July 6 to Sept. 10 if slope and exposure are normal.

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3. Slope and Exposure--If slope is long, steep and exposed to prevailing wind, set slide as follows:

Slope	Season	Indicator
35-60%	Pre & Post	(1)
Over 60%	Pre & Post	(2)
35-60%	Mid-season	(2)
Over 60%	Mid-season	(3)

----

4. Relative Humidity--If below 15%, read next fuel moisture content class to right. If already under 5%, read next higher wind-velocity class.

----

5. General--Weather conditions should be determined as accurately as possible at the time and for the vicinity where fire is located.

BACK

1

2

3

2	2	2	3	4	4.5	5
2	2	3	4	4.5	5	5.4
2	3	4	4.5	5	5.4	5.7
3	3	4	4.5	5.4	5.7	6.3
3	4	4.5	5	5.7	6.3	6.8
4	4	5	5.4	6	6.6	7
4	4.5	5	5.7	6.3	6.8	7.2
4.5	5	5.4	6	6.6	7	7.4
5	5.4	5.7	6.3	6.8	7.4	7.5

P

1

2

3

SLIDE

DISPATCHER'S GUIDE CHARTS - PERIMETER-INCREASE DATA

Chart One

Spread Danger Class	Fuel Type: Low	Med.	High	Ext.
	Perim. Incr. Factor (First-Hour Perimeter)			
2	.04	.08	.16	.2
3	.08	.2	.32	.6
4	.6	.8	1.0	1.8
4.5	1.0	1.2	1.6	2.8
5	1.6	2.0	2.8	4.8
5.4	2.6	3.8	5.0	8.1
5.7	3.7	5.8	7.5	12.
6	5.6	8.4	11.	17.
6.3	8.2	12.	16.	25.
6.6	11.	15.	20.	33.
6.8	12.	18.	23.	39.
7	14.	20.	26.	46.
7.2	16.	23.	30.	51.
7.4	17.	25.	33.	56.
7.5	18.	26.	35.	59.

Chart Two

Time of Discovery	Time Objectives: 1st Per'd	12 p.m.	11 p.m.	10 p.m.	9 p.m.	8 p.m.	7 p.m.	6 p.m.	5 p.m.	4 p.m.	3 p.m.	2 p.m.	1 p.m.	12 noon	11 a.m.	10 a.m.
	Perimeter-Increase Factor Multipliers - According to Time Objectives Used															
9 a.m.	82	78	75	70	63	56	49	42	35	28	21	15	10	6	3	1
10 a.m.	75	72	69	63	56	49	42	35	28	21	15	10	6	3	1	
11 a.m.	68	65	61	56	49	42	35	28	21	15	10	6	3	1		
12 noon	61	58	54	49	42	35	28	21	15	10	6	3	1			
1 p.m.	49	47	44	39	33	27	21	15	10	6	3	1				
2 p.m.	39	37	34	30	25	20	15	10	6	3	1					
3 p.m.	29	27	25	22	18	14	10	6	3	1						
4 p.m.	21	19	17	14	12	9	6	3	1							
5 p.m.	18	16	14	12	9	6	3	1								
6 p.m.	15	13	11	9	6	3	1									
7 p.m.	12	10	8	6	3	1										
8 p.m.	8	7	5	3	1											

Night Fires: For discoveries between 5 a.m. and 9 a.m. increase the discovery hour by the required number of hours to advance it to 9 a.m. Then advance both the estimated arrival time and the corral objective the same number of hours and work out probabilities on the basis of a 9 a.m. discovery. Example: 6 a.m. discovery, 8 a.m. arrival and 10 a.m. corral would be worked thus - 9 a.m. discovery, 11 a.m. arrival and 1 p.m. corral.

For all other night fires (between 9 p.m. and 5 a.m.) simply reverse a.m. hours to p.m.'s and p.m. hours to a.m.'s and use charts direct as for a daytime discovery. Example: 11 p.m. discovery, 1 a.m. arrival and 6 a.m. corral would be worked out as an 11 a.m. discovery, 1 p.m. arrival, and 6 p.m. corral. Remember - the danger class used must represent night conditions at site of fire.

(The data contained herein is intended for use as a guide for dispatching.)

Instructions For Using Region One Dispatcher Guide Charts — Western Forests

a. Factors that must be carefully considered in any method of calculating fire probabilities or determining man-power needs. The influence of these factors has been given consideration in the Region One charts, insofar as possible to determine from the limited amount of data available:

1. Fuels:
   a. Continuity
   b. Size
   c. Volume
   d. Arrangement
2. Topography:
   a. Slope
   b. Exposure
3. Wind:
   a. Velocity
   b. Direction
   c. Duration
4. Fuel Moisture:
   a. Humidity (existing)
   b. ½″ and less fuels
   c. Precipitation (previous)
   d. Large fuels (2″ plus)
5. Size of Crew:
   a. No. of men (losses through placement and supervision)
6. Character of Crew and Overhead:
   a. Experience
   b. Training
   c. Adaptability
7. Fuel Resistance:
   a. Same as 1—a, b, c, d except as each affects held-line output
8. Fatigue:
   a. Length of work period (varies greatly with type of men used)
9. Discovery Time:
   a. Actual
10. Arrival Time:
    a. Estimated (sufficient force to deter spread as calculated)
11. Corral Time:
    a. Objective (established arbitrarily)
12. Method of Attack:
    a. Frontal
    b. Flanking

b. *Suggested Methods of Obtaining Timely Measurements of Factor Influence*

1. *Through observing agencies:* Lookouts, smokechasers, crewmen—glasses or telescope may be used.

2. *Intimate personal knowledge* of dispatcher or other persons immediately available.

3. *Nearest inflammability stations:* Wind gauges, psychrometer locations, etc. Several readings daily.

4. *Fuel type map:* For general information and to be relied upon when 1 and 2 fail to serve need.

5. *Current weather records:* Fuel moisture, wind, humidity, rainfall, etc., as recorded several times daily.

c. *Calculating Probabilities With Region One Guide Charts*

1. *Ascertain danger class* from spread danger meter. Adjust actual measurements, secured from sources nearest to fire, by carefully comparing slope, exposure, timber stand (dense, average or open), exposure to wind, elevation, rainfall (recent and past), time of day, etc.

2. *Ascertain rate of spread factor* from Chart I. Select proper danger class, in first column, then refer to proper rate of spread (fuel type) column, on same danger class line, and rate of spread factor will be indicated. Determine proper rate of spread (fuel type) by methods suggested under b 1, 2 and 4 above.

3. *Ascertain perimeter increase factors* from Chart II. In first column select time of discovery of fire (to nearest preceding hour), thence across chart to proper arrival time and corral time columns. Thereunder will be indicated the proper multipliers to be used in determining the probable *free burning* perimeters from discovery to arrival and from discovery to corral time. The percentage of the difference between the arrival time perimeter and corral time perimeter which should be allowed depends entirely upon strength of attacking force and the method of attack anticipated. The arrival time perimeter plus the corral period allowance equals total job size anticipated.

4. *Ascertain man-power needs* from Chart III. Divide total chains of anticipated perimeter by the smokechaser output rate for the fuel type concerned. This gives the number of smokechaser hours of work to be done. In first column select number of hours calculated in corral period,

follow this line to right until an output figure equal to number of hours of smokechaser work is found. At top of column will be shown number of men required to do the job, with allowance made for factors a 5, 6, 7 and 8, as set forth above.

5. *Night fires:* Between 9 p.m. and 9 a.m. Chart II may be used in the same manner as for daytime discoveries except for multipliers shown in column two. These are for daytime discoveries only and are applicable when a dispatcher desires to determine the probable perimeter of a fire which has escaped corralling throughout the first day. To determine job size for second a.m. corralling.

6. *Example:* August 7, normal slopes, normal humidity, 4-5 mile wind, 9% fuel moisture—D.C. 5. Fuel type is medium spread and medium resistance; discovery time is 10 a.m.; arrival time is 12 noon; corral objective is 2 p.m. Chart I gives a spread factor of 2.0. Chart II gives an arrival time multiplier of 3 and a corral time multiplier of 10. Thus probable perimeter on arrival is 2.0 x 3 or 6 chains. Discovery to corral time perimeter is 2.0 x 10 or 20 chains. 20 minus 6 is 14 chains or free burning increase during corral period. If frontal attack is planned 25% should be sufficient allowance. Thus 6 chains plus 25% of 14 chains equals 9.5 chains or probable total job size.

DISPATCHER'S GUIDE CHARTS – CORRAL-LINE OUTPUT DATA

SMOKECHASER OUTPUT FIGURES BASED UPON ESTIMATES OF APPROXIMATELY 150 EXPERIENCED MEN, 1000 ESTIMATES TAKEN IN 1930 AND 600 IN 1935 AND 1936.
OUTPUT = EXTREME, .25 CH.; HIGH, .8 CH.; MEDIUM, 2.0 CH.; LOW 3.3 CH.

HOURS OF WORK	SMOKECHASER UNITS OF OUTPUT ACCORDING TO SIZE OF CREW EMPLOYED AND NUMBER HOURS WORKED																			FATIGUE FACTOR APPLICABLE ACCORDING TO NUMBER HOURS WORKED
	NUMBER OF MEN																			
	1	2	3	4	5	7	10	15	20	25	30	40	50	75	100	125	150	175	200	
1	1.00	2.00	3.00	4.00	4.95	6.86	9.50	12.7	14.0	15.0	15.9	19.2	22.5	30.0	35.0	40.6	45.0	48.1	50.0	100
2	2.00	4.00	6.00	8.00	9.90	13.7	19.0	25.5	28.0	30.0	31.8	38.4	45.0	60.0	70.0	81.3	90.0	96.3	100.	100
3	2.97	5.94	8.91	11.9	14.7	20.4	28.2	37.9	41.6	44.6	47.2	57.0	66.8	89.1	103.	121.	133.	143.	149.	97
4	3.82	7.64	11.5	15.3	18.9	26.2	36.3	48.7	53.5	57.3	50.7	73.3	86.0	115.	134.	155.	172.	184.	191.	85
5	4.51	9.02	13.5	18.0	22.3	30.9	42.8	57.5	63.1	67.7	71.7	86.6	101.	135.	158.	183.	203.	217.	225.	69
6	5.06	10.01	15.2	20.2	25.0	34.7	48.1	64.5	70.8	75.9	80.5	97.1	114.	152.	177.	205.	228.	243.	253.	55
7	5.52	11.0	16.5	22.1	27.3	37.9	52.4	70.4	77.3	82.8	67.8	106.	124.	166.	193.	224.	248.	266.	276.	46
8	5.92	11.8	17.8	23.7	29.3	40.6	56.2	75.5	82.9	88.8	94.1	114.	133.	178.	207.	241.	266.	285.	296.	40
9	6.27	12.5	18.8	25.1	31.0	43.0	59.5	79.9	87.7	94.0	99.7	120.	141.	188.	219.	255.	282.	301.	313.	35
10	6.60	13.2	19.8	26.4	32.7	45.3	62.7	84.1	92.4	99.0	105.	127.	149.	198.	231.	268.	297.	318.	330.	33
11	6.91	13.8	20.7	27.6	34.1	47.4	65.6	88.1	96.7	104.	110.	133.	155.	207.	242.	281.	311.	333.	345.	31
12	7.21	14.4	21.6	28.8	35.7	49.5	68.5	91.9	101.	108.	115.	138.	162.	216.	252.	293.	324.	347.	361.	30
13	7.50	15.0	22.5	30.0	37.1	51.4	71.2	95.6	105.	113.	119.	144.	169.	225.	263.	305.	337.	361.	375.	29
14	7.78	15.6	23.3	31.1	38.5	53.4	73.9	99.2	109.	117.	124.	149.	175.	233.	272.	316.	350.	374.	389.	28
15	8.05	16.1	24.1	32.2	39.9	55.2	76.5	103.	113.	121.	128.	155.	181.	241.	282.	327.	362.	387.	403.	27
16	8.31	16.6	24.9	33.2	41.1	57.0	78.9	106.	116.	125.	132.	159.	187.	249.	291.	338.	374.	400.	415.	26
17	8.56	17.1	25.7	34.2	42.4	58.7	81.3	109.	120.	128.	136.	164.	193.	257.	300.	348.	385.	412.	428.	25
18	8.80	17.6	26.4	35.2	43.6	60.3	83.6	112.	123.	132.	140.	169.	198.	264.	308.	357.	396.	423.	440.	24
19	9.03	18.0	27.0	36.1	44.7	61.9	85.8	115.	126.	135.	144.	173.	203.	271.	316.	367.	406.	435.	451.	23
20	9.25	18.5	27.7	37.0	45.8	63.4	87.9	118.	129.	139.	147.	178.	208.	277.	324.	376.	416.	445.	463.	22
	100	100	100	100	99	98	95	85	70	60	53	48	45	40	35	32.5	30	27.5	25	← SIZE OF CREW FACTOR

OUTPUT FIGURES SHOWN ARE BASED UPON DAYLIGHT WORK. OVERHEAD HAS BEEN ASSUMED TO CONSIST OF ONE QUALIFIED FOREMAN AND THREE QUALIFIED STRAWBOSSES PER 25-MAN UNIT WITH CORRESPONDING NUMBER OF FIRE OR SECTOR FOREMEN, FOREST OFFICERS, ETC. THIS DATA FOR USE AS A GUIDE.
(DIVIDE CHAINS OF WORK BY SC OUTPUT RATE BEFORE USING THIS CHART TO GET MAN POWER.)

DISPATCHER ACTION RECORD FORM R-1-F-12—PART ONE

This form is provided as a dispatcher's "Tickler List" and for use as a means of recording, in rough scratch form, the history of action taken upon each fire requiring suppression effort of more than 25 men. It also provides ample space for rough notes and calculation of probabilities. Its use (together with part two when reinforcements are needed) is intended to eliminate the need for any other fire dispatching form or record of dispatching actions. The extent to which the various parts of the form is filled out in individual cases will be governed by the needs in each case. Therefore, it becomes a responsibility of the dispatcher to determine when sufficient information has been recorded and when adequate calculations have been made to serve as the basis for dispatching.

Page One of Form R-1-F-12:

This provides space for recording information, in any required amount, as furnished by the discovering agency or by other observing agents, if more than one.

Page Two:

This provides space for recording the initial first line action taken. Following this record is a general tickler list and space for recording probabilities and man-power needs based on further study of fuels, weather and the behavior of the fire. Dispatchers will be furnished with "Calculation of Probability Guide Charts" upon which will appear more detailed instructions on this phase of their job. These charts are to be used only as guides, or as a check against judgment. The dispatcher will take such action as appears necessary in his judgment, then check such action by means of the charts.

Page Three:

This page provides space for recording the follow-up action taken, based upon preceding calculations. It also provides space for a recapitulation of the job size. if such is deemed necessary.

Dispatcher Action Record, Part Two:

This is a tickler list, record of calculation of probabilities and action taken on fires requiring heavy reinforcements. While the principles of calculating spread and man-power needs are the same as for small fires, it involves such a large area of varying fuels, and other factors affecting spread and needs for men and equipment that the ablest men on the forest, or even in the Region, must be called to the task. So many variables are involved that no complete guide can be furnished, but special weight should be given to (1) history of the behavior of the fire (2) danger rating of the season as a whole and probability of catastrophic fires (3) difficulties and lost time in placing men advantageously (4) likelihood of spot fires and difficulty of holding line (5) reasonable output to expect under all existing conditions.

General:

Each part of Form R-1-F-12 contains extra scratch paper upon which all necessary calculations should be made. Also, rough notes of pertinent data should be recorded thereon. In this manner a complete and comprehensive history of action will have been preserved intact for each fire from which the 929 report and analysis of action can be made.

The original Dispatcher Action Record, Form R-1-F-12, will accompany Form 929 fire report to the supervisor's office for all fires upon which a force of 25 men or more were worked.

RELATIONSHIP OF AREA TO PERIMETER

The following tables are supplied to determine the approximate lengths of perimeters of fires of varying areas and shapes.

The first column of the table, headed "Area" shows areas in the units being used, viz., square feet, square chains or square miles. If square chains are used to express the area, the perimeter in the remaining columns is in chains, if square feet are used, the perimeter is shown in feet, etc. Acres must be converted to square chains or square feet to permit use of this table. The three columns to the right of the area column show perimeter corresponding to the area shown by three classes.

First perimeter column shows the minimum perimeter possible for the area, that of a circle of the same area. It would represent a fire in which the spread was uniform in all directions. Third perimeter column represents twice the minimum shown in column one and gives the perimeter for fires which are long and narrow or which finger out. From field and statistical checks this appears to be a satisfactory figure. Second perimeter column represents the probable perimeter one-half way between the maximum and the minimum for the specified area. The figures in this column are applicable to the fire of average shape which is neither circular nor extremely elongated.

AREA — PERIMETER TABLE

Perimeter of Fire Corresponding With Area Enclosed By It

Perimeter is shown in linear units of the same kind as the square units used for area

AREA	Minimum[1] perimeter 1 C	Probable[2] perimeter 1.5 C	Maximum[3] perimeter 2 C
1.0	3.5	5.25	7.00
2.0	5.0	7.50	10.00
3.0	6.1	9.15	12.20
4.0	7.1	10.65	14.20
5.0	8.0	12.00	16.00
6.0	8.7	13.05	17.40
7.0	9.4	14.10	18.80
8.0	10.0	15.00	20.00
9.0	10.6	15.90	21.20
10.0	11.2	16.80	22.40
11.0	11.7	17.55	23.40
12.0	12.3	18.45	24.60
13.0	12.8	19.20	25.60
14.0	13.2	19.80	26.40
15.0	13.7	20.55	27.40
16.0	14.2	21.30	28.40
17.0	14.6	21.90	29.20
18.0	15.1	22.65	30.20
19.0	15.5	23.25	31.00
20.0	15.9	23.85	31.80
22.5	16.8	25.20	33.60
25.0	17.7	20.55	35.40
27.5	18.6	27.90	37.20
30.0	19.4	29.10	38.80
32.5	20.3	30.45	40.60
35.0	21.0	31.50	42.00
37.5	21.7	32.55	43.40
40.0	22.4	33.60	44.80
42.5	23.2	34.80	46.40
45.0	23.7	35.55	47.40
47.5	24.5	36.75	49.00
50.0	25.0	37.50	50.00
52.5	25.8	38.70	51.60
55.0	26.3	39.45	52.60
57.5	26.8	40.20	53.60
60.0	27.5	41.25	55.00
65.0	28.6	42.90	57.20
70.0	29.7	44.55	59.40
75.0	30.7	46.05	61.40
80.0	31.7	47.55	63.40
85.0	32.6	48.90	65.20
90.0	33.6	50.40	67.20
95.0	34.6	51.90	69.20
100	35.5	53.25	71.00
110	37.2	55.80	74.40
120	38.7	58.05	77.40
130	40.4	60.60	80.80
140	41.9	62.85	83.80
150	43.3	64.95	86.60
160	44.8	67.20	89.60
170	46.2	69.30	92.40
180	47.5	71.25	95.00
190	48.8	73.20	97.60
200	50.2	75.30	100.40
210	51.4	77.10	102.80
220	52.5	78.75	105.00
230	53.7	80.55	107.40
240	54.8	82.20	109.60
250	56.0	84.00	112.00
260	57.1	85.65	114.20
270	58.3	87.45	116.60
280	59.4	89.10	118.80
290	60.4	90.60	120.80
300	61.5	92.25	123.00
320	63.4	95.10	126.80
340	65.4	98.10	130.80
360	67.2	100.80	134.40
380	69.1	103.65	138.20
400	70.9	106.35	141.80
425	73.1	109.65	146.20
450	75.2	112.80	150.40
475	77.2	115.80	154.40
500	79.3	118.95	158.60
550	83.2	124.80	166.40
600	86.8	130.20	173.60
650	90.4	135.60	180.80
700	93.7	140.55	187.40
750	97.0	145.50	194.00
800	100.2	150.30	200.40
850	103.4	155.10	206.80
900	106.3	159.45	212.60
950	109.3	163.95	218.60
1,000	112.1	168.15	224.20
1,050	114.8	172.20	229.60
1,100	117.5	176.25	235.00
1,150	120.2	180.30	240.40
1,200	122.8	184.20	245.60
1,250	125.4	188.10	250.80
1,300	127.8	191.70	255.60
1,350	130.3	195.45	260.60
1,400	132.6	198.90	265.20
1,450	134.9	202.35	269.80
1,500	137.3	205.95	274.60
1,550	139.6	209.40	279.20
1,600	141.8	212.70	283.60
1,650	144.0	216.00	288.00
1,700	146.1	219.15	292.20
1,750	148.3	222.45	296.60
1,800	150.4	225.60	300.80
1,850	152.5	228.75	305.00
1,900	154.6	231.90	309.20
1,950	156.5	234.75	313.00

AREA—PERIMETER TABLE (Cont'd.)

AREA	Minimum[1] perimeter 1 C	Probable[2] perimeter 1.5 C	Maximum[3] perimeter 2 C	AREA	Minimum[1] perimeter 1 C	Probable[2] perimeter 1.5 C	Maximum[3] perimeter 2 C
2,000	159	238	318	102,000	1132	1698	2264
4,000	222	334	445	104,000	1144	1716	2288
6,000	270	405	540	106,000	1154	1731	2308
8,000	317	476	635	108,000	1165	1747	2330
10,000	355	532	710	110,000	1175	1762	2350
12,000	388	581	775	112,000	1185	1777	2370
14,000	417	626	835	114,000	1196	1794	2392
16,000	447	670	893	116,000	1206	1810	2413
18,000	475	712	950	118,000	1216	1824	2432
20,000	500	750	1000	120,000	1226	1839	2452
22,000	525	787	1050	122,000	1236	1854	2472
24,000	550	825	1100	124,000	1246	1869	2492
26,000	574	861	1148	126,000	1257	1885	2514
28,000	595	892	1190	128,000	1266	1899	2532
30,000	615	922	1230	130,000	1275	1912	2550
32,000	635	952	1270	132,000	1286	1929	2572
34,000	655	982	1310	134,000	1295	1942	2590
36,000	675	1012	1350	136,000	1305	1957	2610
38,000	692	1039	1385	138,000	1315	1972	2630
40,000	710	1065	1420	140,000	1324	1986	2648
42,000	727	1091	1455	142,000	1334	2001	2668
44,000	745	1117	1490	144,000	1343	2014	2686
46,000	762	1144	1525	146,000	1351	2026	2702
48,000	778	1168	1557	148,000	1360	2040	2720
50,000	794	1191	1588	150,000	1370	2055	2740
52,000	810	1215	1620	152,000	1379	2068	2758
54,000	825	1237	1650	154,000	1387	2081	2775
56,000	840	1260	1680	156,000	1396	2094	2792
58,000	855	1282	1710	158,000	1405	2107	2810
60,000	870	1305	1740	160,000	1413	2119	2826
62,000	885	1327	1770	162,000	1422	2134	2845
64,000	899	1348	1798	164,000	1431	2146	2862
66,000	912	1369	1825	166,000	1440	2160	2880
68,000	926	1390	1853	168,000	1449	2173	2898
70,000	940	1410	1880	170,000	1456	2184	2912
72,000	953	1429	1905	172,000	1465	2197	2930
74,000	966	1450	1933	174,000	1474	2211	2948
76,000	979	1468	1958	176,000	1481	2221	2962
78,000	992	1488	1984	178,000	1490	2235	2980
80,000	1004	1506	2008	180,000	1499	2248	2998
82,000	1016	1524	2032	182,000	1508	2262	3016
84,000	1028	1543	2057	184,000	1516	2274	3032
86,000	1040	1560	2080	186,000	1525	2287	3050
88,000	1052	1579	2105	188,000	1537	2306	3075
90,000	1064	1596	2128	190,000	1541	2311	3082
92,000	1075	1612	2150	192,000	1550	2325	3100
94,000	1087	1631	2175	194,000	1559	2338	3118
96,000	1099	1648	2198	196,000	1566	2349	3132
98,000	1110	1665	2220	198,000	1575	2362	3150
100,000	1121	1681	2242	200,000	1581	2371	3162

[1] Perimeter is that of a circle corresponding with the area.
[2] Perimeter is 1.5 times that of a circle corresponding with the area.
[3] Perimeter is 2.0 times that of a circle corresponding with the area.

APPRAISAL OF LINE LOCATION JOB, BASED ON PROBABLE LOCATION OF FIRE AND AS A BASIS FOR MOBILIZATION

The Base Map:

The appraisal of probable behavior of the fire results in estimated locations of the fire perimeter at given hours. This is best indicated on a map, which should also show:

1. Topography.
2. Fuel type.
3. Roads, trails, firebreaks, clear rights-of-way, etc.

4. Natural barriers.
5. Possible fire camp sites.

Elements in First Plan of Line Location:

Elements to take into account:

Barriers:

Use of barriers, artificial or natural, that fire is estimated to reach or approach in any event, such as slides, canyons, wet meadows, recent burns, firebreaks, cleared rights-of-way, etc.

First Sectors:

Sectors of fire that must be attacked first and directly to halt spread (a) into high-value areas, (b) into areas where spread will be more rapid, (c) into types more difficult to build and hold line in (higher resistance to control), (d) into new topographic areas (crossing canyon, getting into new major drainage, etc.).

Direct Attack Sectors:

Direct attack on other sectors where speed of line construction, shortness and directness of lines, probable ability to hold lines, or tie-in to sectors selected make such location best.

Indirect Attack Sectors:

Backing off from fire to location selected.

(a) To shorten line materially, as in case of a fire with many fingers.
(b) To make line construction more rapid, as in edge of timber instead of through dense fuel areas.
(c) To avoid areas where steepness of country makes holding a direct attack line doubtful, such as foot of slope instead of face of slope.
(d) To keep out of cover in which large crews cannot be spread out to work effectively, such as very dense snag and log areas.

Delayed Attack Sectors:

Sectors that may be ignored in first attack, such as creeping duff fire that can be caught later without difficulty.

The fire boss' map should show the location chosen for all lines and order of attack planned on different sectors. If second lines of defense are to be started concurrently, the location for these must also be chosen.

APPRAISAL OF LINE CONSTRUCTION JOB

The fire boss' map shows first location of lines needed to control fire.

Elements in Estimating Construction Job:

1. Line Production.

Estimate separately for each important type involved in planned location of line, the production (line construction only) per man-hour. The usual basis is linear distance in chains. In estimating production per man-hour, take account of:

(a) Barriers, where line construction job is small or absent; such as roads, trails, streams, slides, cliffs, recent burns, etc. Job may be heavy for mop-up, etc., but not for construction.

(b) Whether large crews can be spread to work effectively, as in open country, or whether they cannot be spread, and speed of crew will be slowed down by inaccessibility, very dense brush, windfalls, etc.

(c) Time of day as influencing efficiency of labor; such as reduction of output on very hot day or at night when working under artificial light.

(d) Whether men are fresh or tired at start of shift.

(e) Quality of labor; whether organized crews of experienced, seasoned men, or unorganized, pick-up crews or labor that will have to be closely supervised to avoid loafing.

(f) Topography as influencing pace of work; whether gentle or moderately smooth slopes or steep rough slopes.

(g) Cumulative fatigue during shift; whether heat, climbing up and down hill, or heavy work, will result in reducing output per hour.

Following is an illustration of the effects of items "c" to "g" above. Assume that on a similar line construction job the output was 2 chains per man-hour. The fire line was built by an experienced and seasoned crew, day work only. Reductions in output for a similar line built under fire conditions might be:

1. For night work	20%
2. Men somewhat fatigued at start	10%
3. Unorganized—but good men—will work	25%
4. Steeper, rougher country	5%
5. Cumulative fatigue from long shifts	15%
Total	75%

—leaving an average of only .50 chains per man-hour.

This is an extreme example—not a recommended basis for actual calculation—but illustrates the need for considering the factors listed in estimating man-hours required for fire line construction.

2. Line Holding.

In addition to the actual construction of lines, calculations of man-power requirements must be made for the line-holding job during the active line-building period.

(a) For line clean-up, firing, snagging, etc.
(b) For mop-up.
(c) For patrol.

In practice, these jobs are handled either:

(a) By progressively dropping off men from the original construction crew. The extent of this drain is known only very generally. Too often, no doubt, it is not even taken into account in the planning. Only on the very lightest jobs, such as in short grass, is there little or no drain of man-power. In other fuel types, it will probably range from 5% to 20% per hour of original crew strength. Very commonly the hourly rate of drain is far in excess of the original estimates.

(b) By planning and organizing special crews, in addition to the line-construction crews. In difficult fuel types it commonly becomes necessary as the job progresses, to divert men from line construction, even when such special crews are initially provided.

Pending the collection of factual material, all that can be done is to recognize and make specific plans for the line-holding jobs.

The following chart illustrates the wastage factor on a fire which might start at

2 p.m., spread rapidly until 7 p.m., level off without appreciable spread during the night, and pick up again at 9 a.m. next morning. On the chart is shown:

(a) Perimeter of fire at any given hour in man-hours of line construction (curve a).

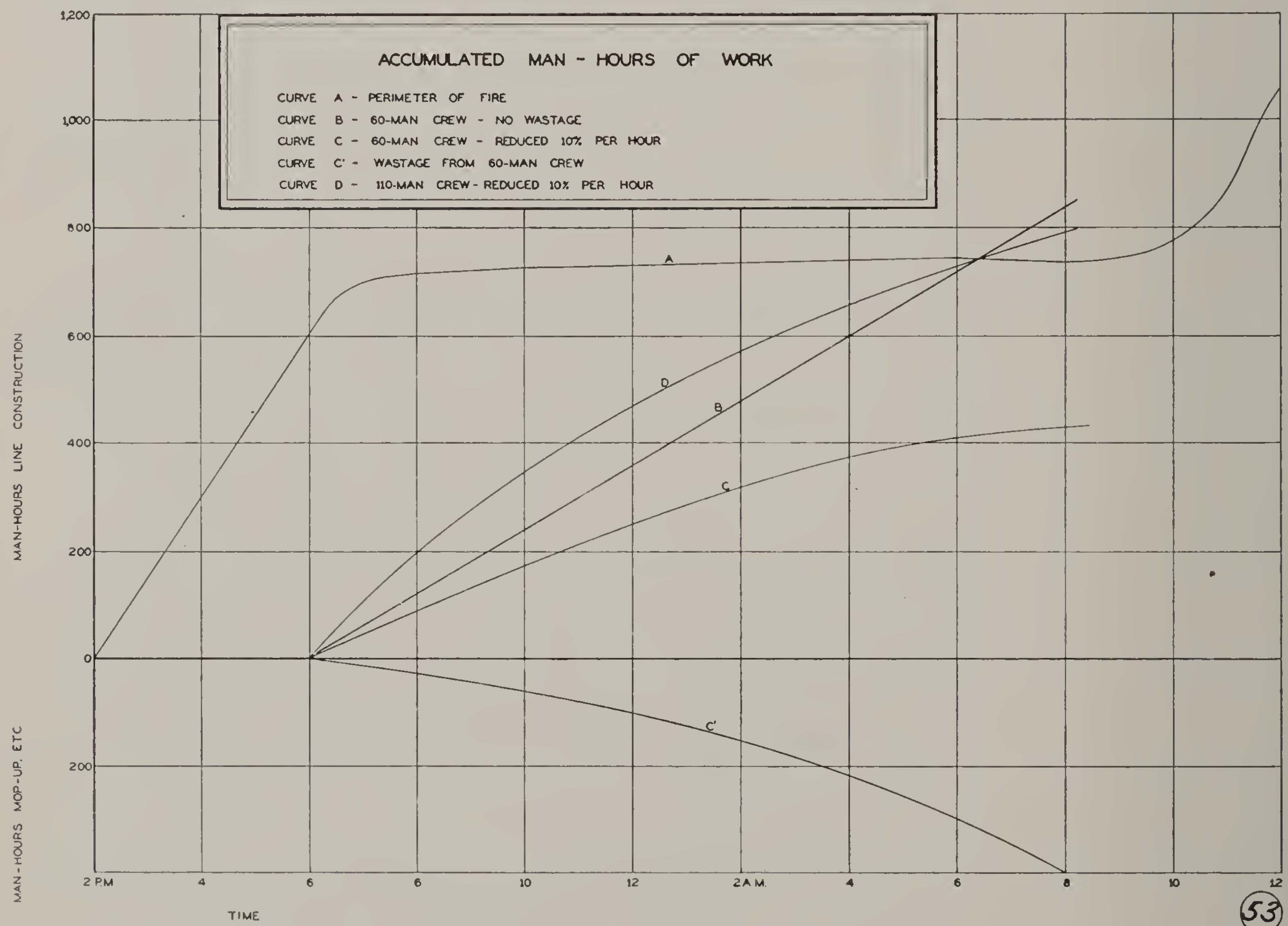
(b) Accumulated man-hours of work at any hour for a crew of 60 men starting work at 6 p.m., and with entire crew continuing on line construction. Note that fire would be surrounded at about 6:30 a.m. (curve b).

(c) Accumulated man-hours of line construction for same crew, but assuming a wastage for mop-up and patrol of 10% per hour. Note that fire would not be controlled during work period (curve c).

(d) Accumulated man-hours of mop-up and patrol of above crew (curve c1).

(e) Accumulated man-hours of line construction of a crew of sufficient initial size (110 men) to control fire during night, with allowance for wastage of 10% per hour (curve d).

Line-production calculations showed that 60 men could control fire by 6:30 a.m., but a consideration of the wastage factors indicated that it would take a crew of 100 men to construct the fire line by 6:30 a.m. This calculation is important in planning man-power needed. The chart is for purposes of illustration only and must not be used as a definite index or gauge.



In calculating man-power and overhead requirements, the mental processes include the consideration and decision as to probable needs for each sector and each division of a fire. As an aid to orderly thinking, as a check list, and as the basis for ordering man-power, overhead and special personnel, a suggested work sheet is shown.

DISPATCHER'S WORK SHEET

Forest...
Fire...
Date...

FACILITIES ORDERED

Overhead

Date	Hour	Sector Overhead Units Position	Sector Overhead Units Place From	Base Camp Overhead Position	Base Camp Overhead Place From	Special Men Position	Special Men Place From

Crewmen

Date	Hour	FF	Place From	CCC	Place From	Other Classes	Place From	Cooks	Place From

Equipment and Supplies

Time Ordered	Time Dispatched	25-Man Tool Outfits	25-Man Sup. Outfits	Beds	Stove and Fly	Rations Sets	Pumps	Hose	Plows	Radio and Oper.	Pack String	Special Items

PLANNING MOBILIZATION

After the estimates of needed man-power, tools, etc., sector by sector, are made, the detailed plan for mobilization can be prepared. Obviously, the planner always has had in mind what is available as he works on the preliminary problems above discussed. A lot of preliminary work has been done; arranging for crews and overhead, rounding up transportation, getting equipment on way, etc. The making of the final mobilization plan, upon which depends first period control, is now in order.

Elements of Mobilization:

The elements to take into account include:

1. The available sources of labor—presumably listed in the Fire Plan charts.
2. Tool and equipment items that will be required in detailed plan of attack. Give particular thought towards getting special equipment, such as trail builders, tanks, trenchers, plows, pumps, etc.
3. The availability of enough competent overhead, including all the kinds required by the type of big fire organization to be used.
4. The availability of all the kinds of transportation that will be needed.

For each of these elements the planner must estimate the number of hours required for the get-away and travel to the camp site selected. The readiness to go on short notice must be known. These considerations are particularly important, since calculations of required strength of attack have been based on an estimated hour at which effective strength will be on the lines.

SAFETY ALLOWANCES

Safety allowances are increases above absolute needs of attack, and are made:

1. Because of possible increase in spread of fire over that estimated.
2. To offset uncertain estimates by the planner.
3. Because estimated time for completion of control may be very close to the next morning deadline.

Reasonable allowance of extra man-power for any such situation is generally desirable. Not all fires, however, are in the class justifying safety by midnight; it usually makes no real difference if it is not done until 2 or 3 a.m. Or, if the special weather forecast is for increasing humidity next day, it goes beyond the bounds of prudence to assume worse conditions ahead. Or, if allowance is simply to ease the mind of the planner, it can hardly be justified.

No detailed rules are possible. Clear recognition is needed that safety allowance is a matter for specific study and decision on each fire.

SUMMARY OF STEPS IN PLANNING ATTACK

The key steps in planning first attack on big fires are:

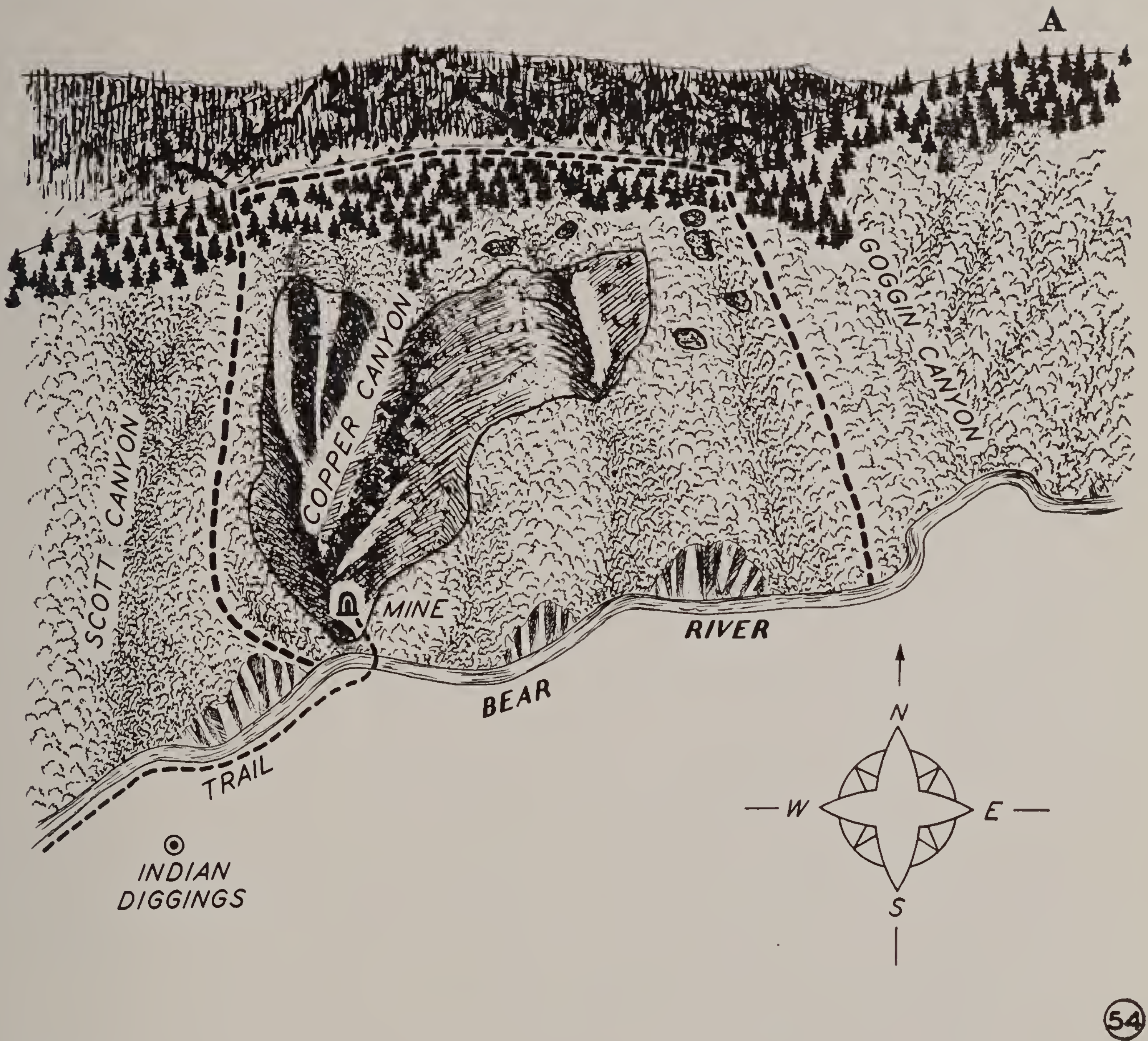
1. Appraisal, shown on a map, of where fire will be at time full attack is effective. This should take into account the effect on rate of spread of fuel type under existing dryness, relative humidity, wind velocity, slope, barriers and number of hours of spread under approximately existing conditions. Normal behavior charts to check judgment concerning probable increases in perimeter.
2. Based on probable location of fire, decisions, sector by sector, where to place lines and the order of importance. This should take into account protection of key areas or high values, use of barriers and reducing size of line construction job where possible.
3. Estimate, sector by sector, strength of attack required separately for:
   - (a) Line construction.
   - (b) Line holding and clean-up. This should take into account loss of output due to fatigue, night work, quality of labor, and of number of hours available for control job.
4. Reasonable safety allowances in strength of attack where justified by specific conditions on individual fires.

PROBLEMS IN PLANNING ATTACK ON LARGE FIRES

Some of the more common problems in planning attack are illustrated in the following cases:

The cases are presented both to show the strategy for given situations and to indicate the processes that must be followed to determine the correct plan of attack on any large fire. Every attempt has been made to emphasize the importance of viewing the job as a whole, forecasting probable fire behavior, making correct selection of lines and mobilizing sufficient man-power and equipment and to do the calculated job of control within the time available.

Effect of Fuel and Topography on Rate of Spread:



Situation:

Fire discovered at 1:30 p.m. and located at old mine in Copper Canyon above Bear River, which is a large and reasonably straight stream. Probable size at discovery, 2 acres. Fire boss sizes up the situation at 3 p.m., at which time the fire is about one and one-half miles long and up to one-half mile wide, representing a spread of about 350 acres in one hour. Somewhat above normal fire danger; probably class 5.4.

Action Required:

1. Study of Topography.

   The slope from the river is steep, up to 90%, and is reasonably uniform. The slope is cut by several sharp ravines, and by Scott, Copper and Goggins Canyons; all gulches of considerable size, particularly Goggins, which is deep and rough. About one mile in an air line north of the river the general slope becomes more gentle, and in about two miles from the river, culminates in a broad, smooth ridge. The total rise from the river to the top of the ridge is approximately 2,000 feet. Beyond the ridge at a distance of

about one mile, is a second ridge of similar character. The two ridges are separated by a shallow canyon about 400 feet deep. The two ridges merge at the hill near point A. (See sketch.)

2. Study of Fuel.

   River slope is in 1910 burned area. The fuel is grass, down timber, brush and medium stand of snags, with occasional patches of reproduction and a few mature trees. The fuel on the ridge is an average stand of ponderosa pine and Douglas Fir, with an understory of scattered reproduction and with clumps of poles and brush, becoming greater in density across the ridge on the north slope. Under the timber, there is a ground cover of needles and in the more open spaces, bunch grass. The edge of the timber belt is about one and one-half miles from the river. The strip of timber on the south side of the ridge is about one-half mile wide. The cover north of the ridge is unbroken timber.

3. Estimate of Rate of Spread.

   If fuel and slope conditions are uniformly the same as on the area already covered by the fire, the expectation would be a fire length of at least five miles and a fire width of possibly two miles by 6 p.m. This would project the fire beyond the second ridge and across both Scott and Goggins Canyons, making a fire of around 5,000 acres. Even under normal weather conditions, spread would continue (but at a reduced rate) during the night. Control lines might involve taking in eight to ten thousand acres with a perimeter of from fifteen to twenty miles.

   (a) Effect of topography.
   However, it is calculated that the rate of spread of the fire, other conditions being equal, will decrease sharply with reductions in slope. The fire boss estimates in this case that it would take at least one and one-half hours for the fire to reach the top of the ridge, assuming no change in fuel. He notes the ravines on the slope, which are already reducing the angle of the normal fan shape of the fire, and are thereby tending to narrow the front in relation to length.

   (b) Effect of fuel type.
   Also, as the fire gets into the green timber, it will crown but rarely, and rate of spread will be reduced materially in the pine needle and brush cover. Adding this effect to the effect of reduction in slope, the fire boss figures that the fire will not reach the top of the ridge before 6 to 7 p.m. Its night spread beyond the top of the ridge will be slow and can be handled by direct attack. The side spread is not likely to go beyond Scott Canyon on the west and the ridge west of Goggins Canyon on the east.

4. Plan of Attack.

   The major sectors are handled in the following order:

   (a) Rear Sector.
   The fire boss already has a crew of ten men on the way to Indian Diggins, via trail, which he proposes will patrol Bear River to guard against spot fires and to clean burn the river slope during the night. Backfires will not be advanced beyond natural side spread of the fire.

(b) Front Sector.

The plan is to construct and backfire a line along or near the top of the ridge, picking as open country as possible and following edge of fire at those places where it may slop over ridge. Advance crews will be sent ahead to work on any fingers that may threaten to spread well beyond the ridge top.

(c) Flank Sectors.

Fire lines will be put down each side and backfired, starting these lines far enough outside the advance of the fire to guard against flanking by the fire. These lines can be built rapidly and safely. Completion of river backfiring will be done after flank backfires are brought to the river.

(d) Lines.

Needed lines are estimated to be one mile along ridge, two and one-quarter miles on each flank, and one and one-half miles along river, a total of seven miles, enclosing an area of approximately 1,500 acres.

Summary of Correct Practices:

1. No panic on account of rapid initial rate of spread.
2. Effect of topography carefully considered.
3. Effect of change in fuel type carefully estimated.
4. Logical plan of attack is made, with correct sequence in handling the various sectors.
5. Lines are selected for ease and safety of construction and for safe holding next day.

Use of Weather Forecasts:

(55)

Situation:

Second week in August. At 2 p.m., second day of dry, hard, southwest wind; fire starts in bottom of canyon, blows up and makes run of 1,000 acres on both sides of canyon. Fire edge part way up slopes on both sides of canyon and near main ridge at head of canyon. Cover moderate mixed timber; fir and yellow pine. Slopes moderate. Soil with little rock, except in scattered outcrops. Medium litter and underbrush. Medium rating. Wind has died down by 5 p.m. and fire spreading slowly.

Man-power and facilities available:

Four CCC camps, leaders, transportation, tools and equipment available. Truck trail along main ridge. Good trails down side ridges. Road up canyon to point one mile above start of fire. Trail from there to head. Good access to head and rear of fire, and flanks accessible by dropping down from trails or climbing up through burn from canyon.

First Case:

Weather Forecast. Sharp increase in relative humidity during night; cloudy and high relative humidity next day. Wind down-canyon and gentle during night, continuing same direction but increasing velocity next day.

This means that during night, fire will die down, flaring in spots; but large part of edge going out, with rest smoldering. Next day fire will probably be more active, but will not run on large scale.

Possible Plans of Attack. Key point is (1) whether to backfire entire canyon from truck trail and ridge trails, or (2) make direct attack by hot spotting and cold trailing. With the fire quiet during night, it is fairly safe to drop men from trails through medium fuel to edge of fire. Considering weather outlook, it is doubtful whether backfires would take hold. Men can be spread out to attack edge in any desired number of places. Even if not all of edge worked first night, favorable conditions next day will make continuation of direct attack safe and possible. Medium resistance fuel means relatively easy for men to work line and not too much work to be put in per unit of line. Decision: to cold trail.

Organization of Attack:

1. Start crews in both directions from High Mountain at head of fire.
2. Start crews from road in both directions on rear and lower flanks of fire.
3. Take other crews to head of road up-canyon, walk them up trail, and progressively send them through burn to both flanks.
4. All crews to have designated sectors marked on ground as well as on maps provided.

Second Case:

Weather Forecast. Decreasing wind velocity during night, but same up-canyon wind. Relative humidity up to 35% during night. Next day relative humidity 20 to 25%; wind 12 to 15 miles per hour. This means fire will remain active during night, except in lee of spur ridges. Burning will be somewhat spotty, but it will not be a quiet fire.

Plan of Attack. Cold trailing impossible; line too hot to work.

Decision: to drop back to road and ridge trails, and backfire out entire canyon, selecting side spurs from both ridges down which to construct backfire lines into canyon to connect with lines on the rear of the fire.

Organization of Attack:

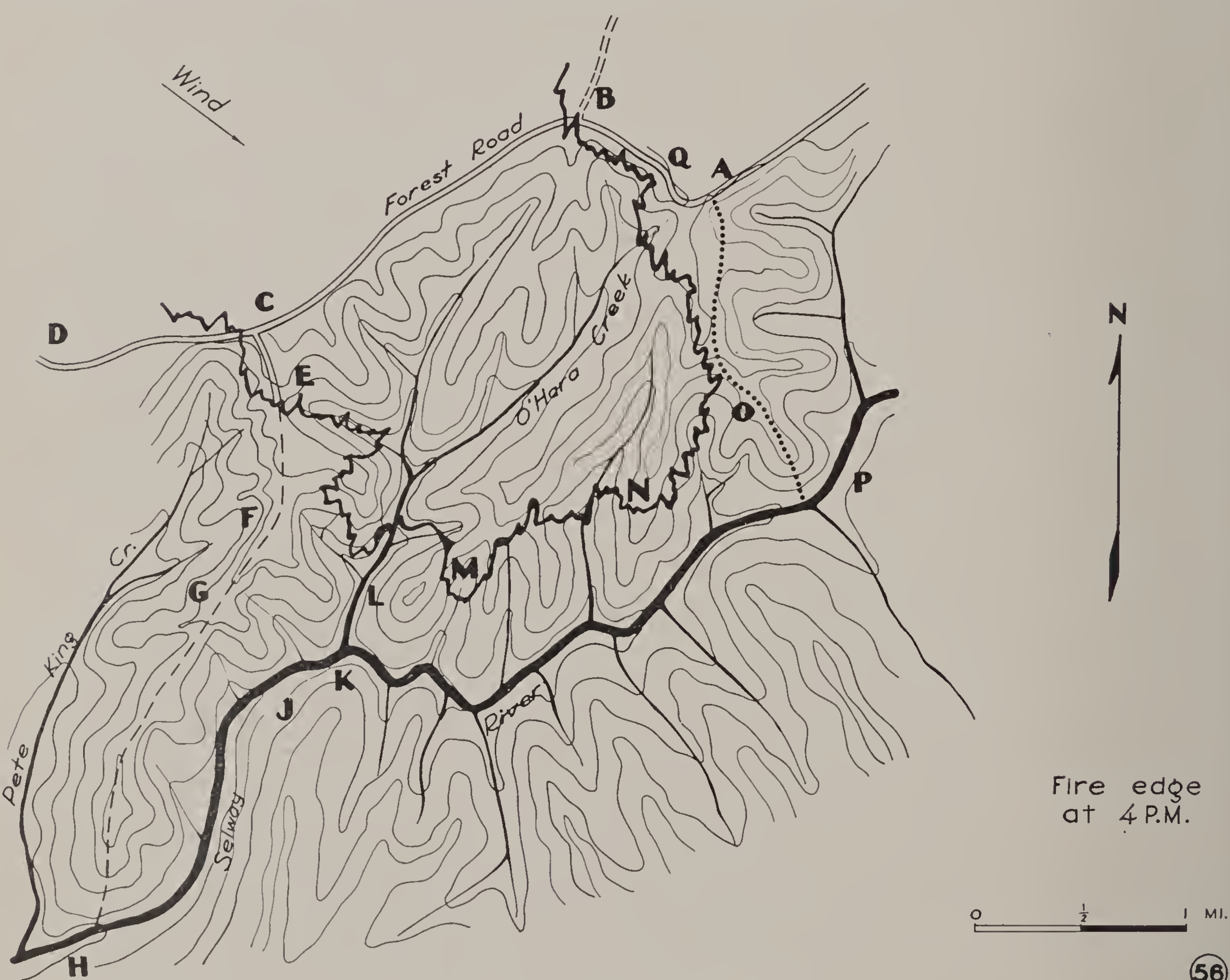
1. Start backfiring crews both directions from High Mountain.
2. Start line construction crews from points A and B down spurs into canyon.
3. Start crews down ridges from C and D to prepare trails for backfiring.
4. When backfires reach trail intersections at C and D, continue down ridges with backfires.
5. Follow with mop-up crews so that backfiring may proceed as fast as possible.
6. Backfire lines A-E and B-E last.

Summary of Correct Practices:

1. With quiet fire during night, use direct cold trailing attack.
2. With active fire at night, drop back and backfire.
3. Use of weather prediction is key factor in determining basic plan of attack.
4. Plan job as a whole.
5. Time operations on various sectors.

PROBLEM 3

Direct or Indirect Attack and Need for Second Line of Defense:



Situation:

Fire has started at noon in late July and has spread over a large territory during the afternoon, crossing road on ridge from point B to a little south of point C. By late afternoon the fire is scattered over O'Hara Canyon, as shown on sketch. The area in this drainage is estimated at 800 acres. The wind has lowered and the fire is

spreading slowly and is expected to smolder only during the night, except where rolling has taken place and small fires are burning uphill.

The cover is medium to heavy fuel, logs, reproduction and scattered snags, and the topography is rough and steep. The difference in elevation between Selway River and ridge A-C is 1,800 feet. The slopes drop abruptly to Selway River and the canyon is narrow.

The wind has been fresh, dropping to gentle in the evening. Relative humidity at 1 p.m. was 14%. Forecast for tomorrow is for somewhat higher relative humidity and lighter wind, but no marked change of weather conditions.

There is a forest road along the main ridge A-D, and a way trail on ridge C-H. There is a narrow foot trail on ridge A-P. There is no trail along Selway River, but it is passable on foot at a rate of about one and one-half miles per hour. The country south of Selway River is a steep, heavy fuel area with no break in fuel and few trails. The access for large crews is difficult, involving several hours' foot travel. Men can be brought in to points B and C over the forest road.

Action Required:

It will be assumed that the portion of the fire northwest of road A-D can be controlled, with control lines connecting with points B and C. This problem is to determine the plan of attack in Selway Canyon, aiming at first night control, but with second line of defense in case attack fails in whole or in part. Keeping fire from crossing Selway River is the most important consideration in order to avoid a long, expensive campaign, with heavy losses.

The most obvious plan of attack is to catch up the slopover at the head of Pete King Creek; to backfire trail C-H; to widen trail on ridge A-P, and to backfire it and to backfire river. Some of the drawbacks of this plan are:

1. Great amount of ridge backfiring necessary (2½ miles from E to H and 1½ miles from A to P), which is a difficult and slow job at night.
2. One and one-half miles of widening to do on trail A-P.
3. Extreme dangers in backfiring 4 miles along Selway River, with its many twists and steep banks.
4. Inclusion of salient G-H-J in fire lines, involving 2½ miles of line to backfire and hold, when main fire has not reached it, nor is likely to reach it during night. This disadvantage can be offset by cutting and backfiring either line G-J or F-K.

For the above reasons, direct attack by cold trailing is considered next. The principal disadvantages are:

1. Long length of undercut line (probably 3 miles of such line between E and O).
2. Rough terrain on river slopes.
3. Generally heavier fuel than on ridges.

The principal advantages are:

1. No threat to area south of river if attack is successful.
2. Topography such that cold trailing is possible although difficult.
3. Certainty, if plan is successful, of first night control.
4. Possibility in this case of making the attack from several points, such as from E, M, N and O, but taking crews through the burn.
5. Favorable night weather expected.

The decision is to make the direct attack. The controlling reason is the safety it affords against the fire jumping the river. Another is that attack can be made at several points simultaneously, otherwise the chances of success would be remote. In fact, direct attack from points E and O only would be useless, since two crews, however large, could not possibly complete the job before next burning period. The factors against success are the possibility of flareups during the night, leading to lost line, and the difficulty of making a safe undercut line in rugged country. The real danger is on the line above the river between E and O.

It is judged that, if direct attack fails, it will be necessary to fire the river, probably doing this the second evening, unless conditions are unusually favorable during the second day.

The plan of attack for the first night is summarized as follows:

(a) Direct Attack.

1.	Cold trail slopover in head of Pete King Creek with small crews working from either end.	10 chains.
2.	Start cold trailing at E into O'Hara Canyon.	40 chains.
3.	Start two crews at M cold trailing in both directions.	40 chains and 30 chains.
4.	Start two crews at N cold trailing in both directions.	30 chains and 20 chains.
5.	Start two crews at O cold trailing in both directions.	20 chains and 40 chains.
6.	Start crew at A cold trailing in both directions.	25 chains.
7.	Start crew at B cold trailing in both directions.	10 chains.

(b) Safety Measures. (To allow for possible spread in case of failure of the direct attack.)

1. Widen trail from O to P and prepare for backfiring. 30 chains.
2. Construct a line from a point on trail C-H to a point on river. Ridge G is considered too far from the main fire and would increase probability of fire spotting across river due to prevailing wind direction, so F-K is selected.
3. Prepare river for backfiring by felling snags exposed to wind and isolating dangerous fuel bodies at the mouths of side canyons. This work is planned to start at daylight; all other work at 6:30 p.m.

The following illustrates proper use of second defense lines:

Possible Situation:

Crews working out of M and N have difficulty all night, and at 2 a.m. fire rolls into steep canyons nearly to river. Small segments of fire run up under the line from rolling burning material. It becomes clear that much of the line between O and main O'Hara Canyon cannot be completed during the night work period, and possibly cannot be held at all. Crew from E has good cold trail to point L in canyon. Crews from B to O succeed in completing a similar job on that line.

Action Required:

1. Start backfiring line O-P from the top, completing as soon as possible.
2. Clean out O'Hara Canyon from L to K, but do not backfire.
3. Plan to have crews along river during the next day, allowing fire to burn

down. Clean burn or backfire the remaining strips along the river, including lower end of O'Hara Canyon, late the next afternoon or early evening, depending upon the weather. Do not wait longer than necessary.

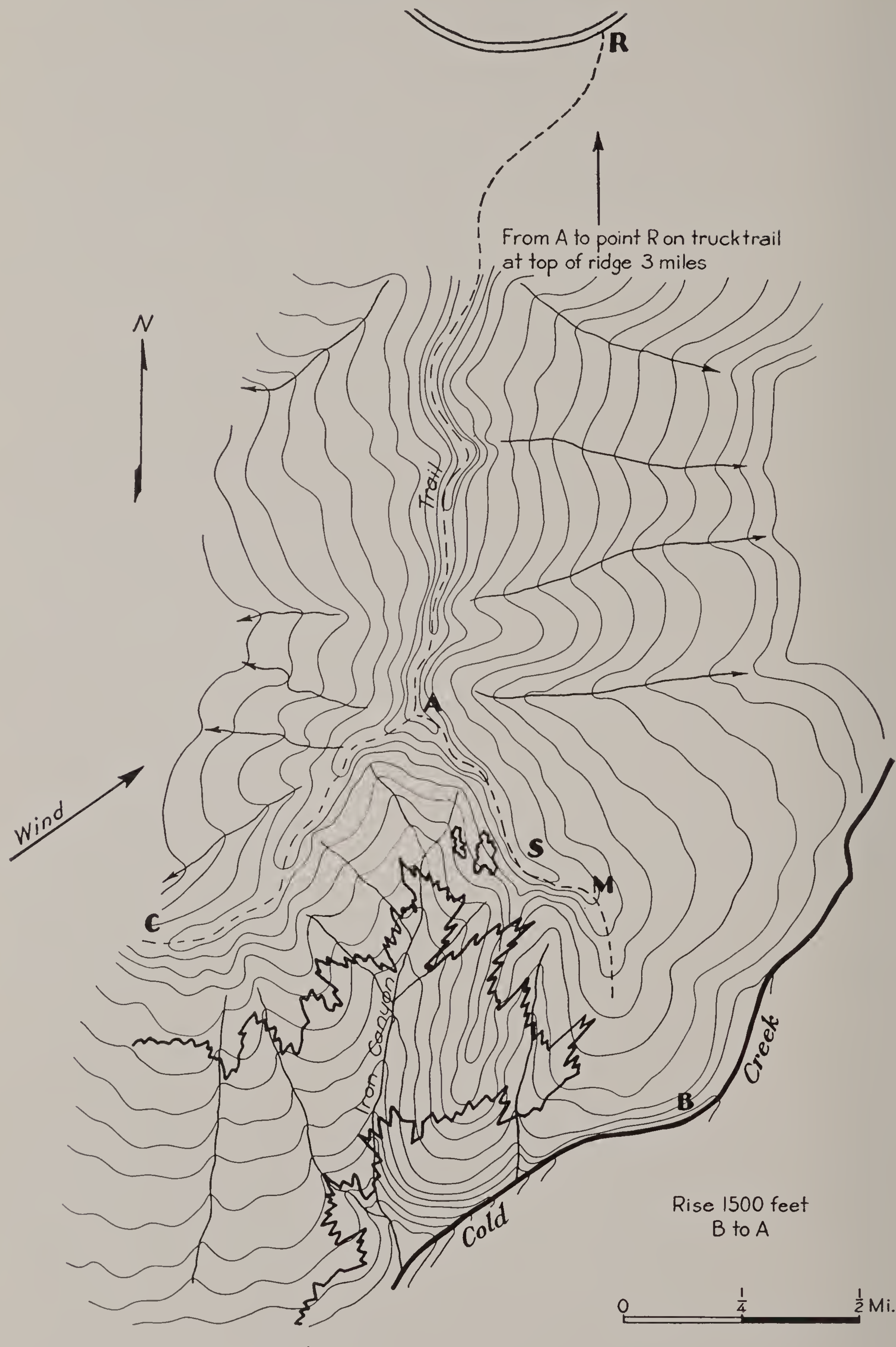
4. Complete cutting of F-K, but do not backfire unless the fire gets away on line E-L or in O'Hara Canyon.

Summary of Correct Practices:

1. Size up situation as a whole.
2. Determine what sectors can be handled independently of main plan, and what methods to employ (lines E-L and B-O).
3. Select method with least possible threat of catastrophe and promising quickest control.
4. Carefully plan simultaneous attacks at all accessible points.
5. Start second line of defense preparations.
6. Recognize promptly failure of direct attack and backfire one line before morning.
7. Take advantage of the success of a portion of the direct attack and tie this portion of the line to the final line along the river by the most practicable direct route.
8. Allow fire to back down to river rather than to set a wholesale backfire, even if this means that control is postponed until the second evening.

PROBLEM 4

Type of Line Needed and Number of Men Required:



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Situation:

1. General Conditions on Fire.

   A large fire burning in late afternoon in early August. Brisk southwest wind. Considering fuel, topography and forecasted night weather conditions, it is expected to spatter itself over Iron Canyon (see sketch) but not to get beyond the eastern edge of the Iron Canyon watershed during the night. Probable position of fire edge by 8 p.m. is shown on sketch, with little night spread expected after that time. One possible danger point is the small saddle at point "S" on sketch.

   General plan of control includes crews working in Cold Creek, the backfiring of trail from point A past point C, and the construction and backfiring of line A-B from trail to Cold Creek. The subsequent discussion will cover line A-B only.

2. Fuel and Topography.

   Fire in 1926 burn. The fuel on ridge A-B is logs, snags, Ceanothus and reproduction from four to six feet tall and of medium density (penetration difficult but some thin spots on steeper and rockier portions of ridge) except in vicinity of saddle, where brush averages seven feet high and is very dense for about ten chains. The ridge is fairly sharp except at the saddle and at the lower end near point B. The grade of the ridge varies from 0% to 80%.

   The total length of line A-B is 90 chains, and point B is approximately 1,500 feet below point A in elevation.

3. Conditions Governing Access, Time of Beginning of Work, etc. Men can be trucked to point R on truck trail, after eating, to arrive by 6:30 p.m. It is three miles over a poor trail from point R to point A. It will take crews one and one-half hours to make this trip, carrying tools, lunch and canteen, including a short rest after arrival. Pack service has been planned to bring to point A supplemental supply of water, extra tools and communication equipment.

   Access to point B is by one and one-half hours' walk over a canyon trail, with some danger to men enroute from rolling rocks, snags, etc. Backfiring cannot start from bottom, as men cutting from point B would have no refuge in case of sudden runs by the fire. It is necessary to start backfiring on line A-B as early as possible, not only to insure completion of the job by morning, but also to allow backfiring of trail A-C (which should start simultaneously with that on line A-B) to get under way. The saddle at point S should be safeguarded as early as possible, which can be handled better by starting from A. For these reasons, all forces will assemble at point A. Safety to men assembling at point A is not a problem.

Solution of Problem:

1. Backfiring.

   Backfiring of line A-B should lag behind line construction by about ten chains until point M beyond the saddle is reached, after which time it can be pushed closer. (See sketch No. 45, Section 2.)

   Backfiring should be completed by 5 a.m. to allow for burning out of lower end of line and Cold Creek reasonably well by 6 a.m. and completely by 8 a.m. The distribution of relief crew will be effective at lower end of line at about 6 a.m.

The time elements for night crews are summarized as follows:

Line construction	8 p.m. to 4:30 a.m.
Backfiring	9 p.m. to 5 a.m.
Mop-up	9 p.m. to 6 a.m.
Patrol	9 p.m. to 6 a.m.

2. Character of Line.

In cover as described, on a fairly sharp ridge, and with a light wind expected, the width necessary is judged to be four feet, except for ten chains in the vicinity of the saddle, where a width of twelve feet will be needed. In certain short sections of the line it may be safe to skimp the above widths. The line should be cleared to mineral soil for an average width of one-half to one foot. The line will hug the east side of the ridge to the extent practicable. All dangerous snags inside should be felled before backfiring if possible. Otherwise, fell most dangerous ones.

3. Man-power Needed.

(a) Line Cutting. Under the fuel type conditions described, it is estimated that a reasonably fresh man can build approximately 1/10 chains per man-hour. This estimate is applicable to 80 chains of the line only. On ten chains of fire line, the production is estimated to be but 1/20 chains per man-hour; therefore, the job calls for 1,000 man-hours.

Practically all the work will have to be performed at night, and toward morning the crew will be tired, even after a planned one-hour rest during the midnight lunch period. The necessity of having to work under poor light is estimated to reduce output 10%. The rest period reduces output 1 hour out of 8½, or 11%. The fatigue factor is estimated to reduce output 40% toward the end of the job, and the average effect is estimated at 15%. The above estimate of total man-hours required, corrected for rest period, darkness and fatigue, becomes 1,600.

(b) The actual backfiring crew needed, consists of six men; three with torches, and three lighting auxiliary fires below the backfire line.

(c) The crew attending backfiring to dirt down if necessary, to catch spot fires, and for preliminary mop-up is estimated at 20 men.

(d) The patrol will be left behind as firing proceeds, with a moving up of some of the men as the fire burns away to a safe distance. The maximum number will be strung out as the backfiring comes to an end, and is estimated to be 40 men. The average is estimated at 25 men.

(e) Summary of man-power:

	Time excluding rest period hours.	Man-hours.	Average No. of men.
Line building	7½	1,600	213
Backfiring	7	42	6
Mop-up	9	180	20
Patrol	9	225	25
Total		2,047	264

Summary of Correct Practices:

1. Careful estimate of the whole control job is made by considering:
   (a) Character of fuel.
   (b) Unit output.
   (c) Additional size of job due to situation in saddle.
   (d) Lack of effectiveness of labor because of certain evaluated factors.
   (e) Auxiliary jobs of backfiring, mop-up, patrol.
   (f) Importance of completion of job by early morning, rather than at latest possible hour.
   (g) Sequence of jobs and correlation with adjoining sectors.

Problem 5

Guarding Against Flanking of Lines:

Situation:

A large fire has started during late August on the south bank of Queens River and has burned to the top of the slope to the east on a wide front. The fire has been controlled along the river and on the north flank. A control line has been brought eastward along the high ridge south of the river to point A, but has not yet been advanced beyond and above the northeast spread of the fire at 3 p.m. The southeast flank is open, as indicated on the sketch.

The cover is grass and scattered brush under timber on the lower slopes, and mixed coniferous timber on the upper slopes and on top of the broad ridge south of the river. The slopes are steep, ranging up to 60% near the river. Weather conditions include a moderate southwest wind and normally low relative humidity of 18% at 1 p.m.

Rested men are available at the main fire camp on top of the ridge. The small crew available out of a spike camp at the mouth of Ned's Gulch is worn out and will be used on the easy job along the river. No men from this camp will be available for major control operations.

Action Required:

The normal plan of attack is to continue construction of line southeast from A, backfiring as built, and to cut a line to the river to prevent spread along the slope, together with whatever attention the river line demands. The essential consideration is to avoid having the line to the river flanked by the fire and thus having to do the job over again. Two solutions are possible:

(a) Send a good-sized crew down to the river to work up along the edge of the fire, holding it on the lower end at or east of Ned's Gulch by hot spotting necessary points, with a clear understanding of the point aimed for by the crew working down from the ridge. Such a plan would mean building line A-B and then line B-C, since upper end of Ned's Gulch would have been burned out, and backfiring line as built, with bottom crew working up along Ned's Gulch.

(b) Extend line A-B along the ridge far enough beyond the fire to insure completion of top line and flank line to canyon before fire can reach the proposed location. Such a plan would involve construction of line A-D, then line D-E, backfiring as built.

In the particular situation described in this problem, line A-D (1¼ miles) and line D-E (1½ miles) are built and backfired by midnight. The lower end of the river line is then backfired, and the fire controlled. If a fresh crew had been available at E, and if Ned's Gulch had been more open, solution (a) above might have been tried with equal success. In this case, however, solution (b) is favored, since line construction from D to E is easier and could be initiated promptly. Safe ridge lines that could surely be held would result, and supervision and correlation of effort are simplified. The danger and uncertainty of success in sending a crew into Ned's Gulch, and the more difficult line to construct and hold, are eliminated. This more than offsets the additional length of line A-D over A-B.

Summary of Correct Practices:

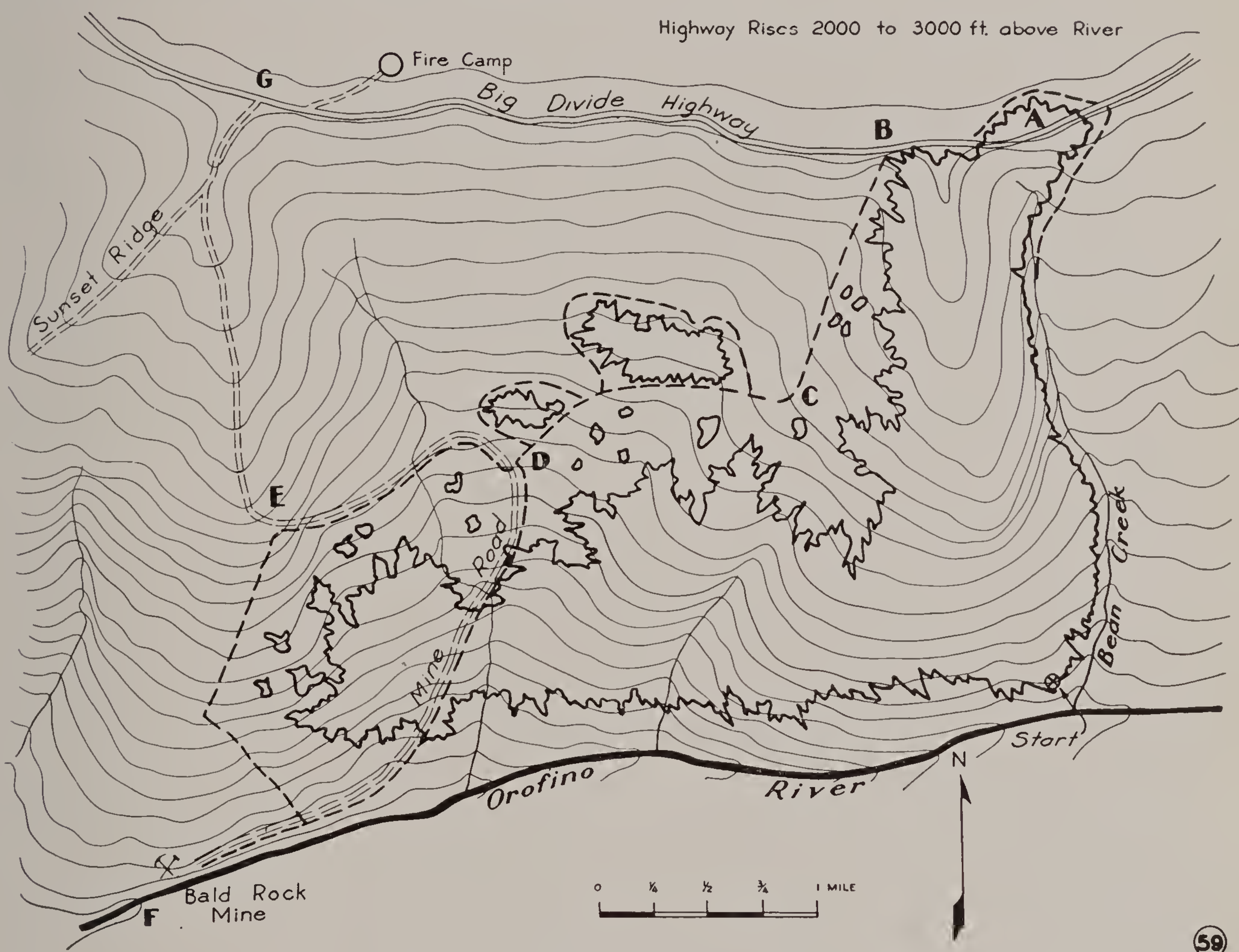
1. Proper planning in line location guarded against flanking of the line.
2. Selection of lines favored routes of easiest and most rapid construction, with greatest sureness of holding.
3. Relatively small additional area of low value included by line A-D (grass and

scattered brush on slope) was given consideration but no great weight in selecting location of lines.

4. Lines were selected to simplify supervision and reduce possibilities of uncorrelated action.
5. Tired men were not depended upon to handle critical sector of the line.

PROBLEM 6

Staying With the Fire in Face of Apparent Disaster:



Situation:

A fire has started at 12:30 p.m. in the middle of August on north side of Orofino River just west of mouth of Bean Creek. Burning conditions had been unusually bad for the time of year. No rain has yet fallen except light showers in late July, and southwest winds had added to the normal season-end dryness of the fuels.

On the day of the fire, there was little wind, and relative humidity was high in the morning. At about noon the wind became fresh and gusty, switching back and forth from southwest to northwest. Relative humidity at 1 p.m. was 12%. The weather forecast was for continuation of the same general conditions, but with prospect of a decided change for the better within thirty-six hours.

Orofino Canyon has extremely steep slopes covered with scattered brush and timber reaching 2,000 to 3,000 feet in elevation above the river. From this rim the general slope back to the main ridge to the north is gentle. Tributary canyons, such as Bean Creek, come down from the main divide every two to three miles. These canyons are steep, but not particularly rocky or broken.

The divide to the north is about two and one-half miles from the river. A state highway follows the divide closely. A minor road, very steep at the lower end, leads down to the Bald Rock Mine. A branch dirt road extends southwesterly down Sunset Ridge for several miles. The distance from the saddle at the head of Bean Creek to the road junction (A to G on sketch) is three and one-half miles.

The first run of the fire, before a gusty wind, was northerly up the west side of Bean Creek. Cliffs and barren spots above the point of origin helped to narrow the initial front. The first crew of ten men arrived at point A at 1:50 p.m., and went down Bean Creek. They held the fire as it backed down the slope and worked toward the divide on the east flank of the fire.

At 3 p.m. the fire had reached the highway at point A, and was spotting across. By this time substantial suppression forces were at hand, and during lulls in the wind, caught and held the spots. The final line in this vicinity is shown on the sketch. The fire was held along the highway to a point near B. At 5 p.m. the wind subsided somewhat, relative humidity rose, and a line was started southwesterly from point B, paralleling the edge of the fire at some distance, and backfired. Around 2:30 or 3 p.m. the fire gained momentum on the steep river slope and swept westward at great speed and scattered fire all along the river slope and edge of the rim. The full force of the east wind carried the fire beyond the Bald Rock Mine road by 4 p.m.

By the time the lull came, at 5 p.m., the fire was established on the slope and had burned well onto the gentle timber slopes.

Action Required:

The general plan of attack was made after reports by scouts, and by 7 p.m. all sectors (except the river, where there was no danger of crossing) were manned and work was started. One crew continued line B-C; a second started from D toward C along the line selected and marked during the scouting; a third started to backfire the mine road from E to D; and a fourth started to construct and backfire a line from E toward the Bald Rock Mine, keeping a little over on the lee or west side of the ridge.

Around 8 p.m. the wind revived somewhat, becoming gusty and tricky, and spot fires were numerous. By 2 a.m., however, all lines had been constructed and backfired except line E-F, which had not yet quite reached the rock slides above the river. At this time the wind rose sharply and numerous spot fires began to occur on the sectors between B and E. All spots were caught until about 2:30 a.m. when the fire got away in several places on sector D-C, and within a few minutes had burned several acres, as shown on sketch.

Conditions were very bad, and it appeared to the sector boss on C-D that the fire was away to a big run; that both lines B-C and E-D would be flanked, and that an entirely new plan of attack would be necessary next day. Instead of taking his crews to camp, however, as one of his foremen suggested, he told his foremen to collect their men at safe places in the burn inside the line and to rest until further orders. He, himself, sat down and took a smoke.

At 3:15 a.m. the wind began to die down, and then within a short time all crown fires dropped to the ground and spread became relatively slow. As these conditions began to be apparent, the sector boss sent his scouts to observe the situation on line B-C, and he, himself, scouted toward point D. There he met the scout from adjoining sector who reported line D-E as being held. He immediately started his crews working around the breaks from both directions. Soon the scout returned from line B-C and reported that this sector seemed to be holding. Confirmed in his belief that no flanking dangers from the other sectors existed, he pushed his crews hard, and by 5 a.m. had the breaks controlled.

At 6 a.m. the wind again began to blow hard from the east, and considerable trouble was had with spot fires. These were all caught, however. The wind again lessened at 8:30 a.m. If the breaks had not been controlled, this morning blow of 2½ hours would have taken the fire to the highway and possibly across Sunset Ridge.

Condition was quiet during the rest of the forenoon. The relief, mop-up and patrol crews were able to get the fire in good condition and hold it during the afternoon blows.

Summary of Correct Practices:

1. Sector boss, despite alarming situation,
   (a) Did not become panic stricken.
   (b) Kept his men in position to attack if conditions changed for the better.
2. Sector boss kept in mind the safety of his men.
3. Contact was maintained with adjacent sectors.
4. Men were rested when no productive work could be done.
5. Changeable nature of wind was recognized.

In this case, observance of these practices made first-night control possible and saved many hundred acres of valuable timber.

PROBLEM 7

Stages in Planning Attack on First Period Fire:

Situation:

1. Fire discovered at 3:00 p.m. early in August.
2. Wind brisk from southeast. Relative humidity 12% at 1 p.m.
3. Fuel: Open stand ponderosa pine on flat at mouth of Monroe Creek. Cover varies from dense reproduction to scattered mature ponderosa pine, with many snags and medium ground understory of brush and small reproduction. On ridges at higher elevations more open ponderosa pine and Douglas fir, but with many scattered dense patches of reproduction and brush. Dry grass in occasional openings in other cover. Approximate rise in elevation from bottom to top 2,500 feet.
4. Monroe Creek dry exceept for short distance at lower flat. Smith River shallow, with gravel wash between river and highway, making a barrier about 400 feet wide.
5. Topography as indicated on attached sketch.

Preliminary Action Taken:

1. 25-man suppression crew with foreman have arrived at 4 p.m. from station twenty miles up highway. Dispatcher is mobilizing a crew of thirty men, with foreman, from Badger Creek road project to arrive on fire at 5 p.m.; three firemen to arrive at same time, one an experienced camp boss. Preliminary warning sent to main CCC camp, one and one-half hours' travel time away, to eat early and get ready to furnish up to 150 firefighters.

   Foreman has started crew working west flank of fire, which is not crowning, with idea of edging it away from steeper lower river slope.

District Ranger Arrives at 3:50 p.m.:

1. The ranger hooks up emergency telephone to Forest Service line at camp site on Monroe Creek and calls dispatcher and gives him brief description of situation as observed coming up highway, checks action already taken, as described above and orders him to start bulldozer with operator from Badger Creek work project. Says he will size up fire and call again.
2. Ranger from low ridge across river sizes up problems as follows:
   - (a) Fire is spreading rapidly toward northwest and has spotted across Monroe Creek, crowning in spots. Right flank not crowning but spreading mainly by roll toward small ravines. Present area about thirty acres.
   - (b) From general weather forecast received in morning, which is no change from general conditions, and from his knowledge of wind and relative humidity behavior during last few days, he feels that wind will drop about 6 to 6:30 p.m. with normal down draft in Monroe Canyon.
   - (c) He observes details of fuel conditions, noting barren cliffs along west rim of Monroe Canyon. He figures fire will die to a ground fire about 6:30 p.m., with perimeter approximately as shown in broken lines on sketch. He expects fire to keep on spreading slowly after that time, especially where fuel is fairly open with a layer of pine needles. If untouched, he would expect fire to attain by morning the perimeter shown by solid line on sketch, possibly slopping over ridges A-B and A-F.
   - (d) He figures control line cannot follow edge of fire without excessive length, many sharp angles, difficult clean-up of unburned patches, construction limited to hand methods, much undercut, hence hard line to

hold next day, uphill draft from burned area, etc. Immediately dismisses this idea, and lays out plan of control as follows, using mainly ridge lines, which minimize the difficulties listed above. Breaks, if they occur, will be relatively easy to catch up.

1. Ridge line from A to B; trail builder line; fall snags and backfire. Will send a small advance crew to this sector to catch any small runs that may occur before trail builder arrives.
2. Cliffs B to C; no work necessary except to make certain no fingers of fuel extend across ridge.
3. C-D on secondary ridge near probable edge of fire; all hand work.
4. D-E; continuation of present direct attack from the lower end.
5. A-F; ridge line by trail builder; snag falling and backfiring.
6. F-E; direct attack if fire permits; otherwise continue tractor line F-G to highway and backfire F-G and G-E (F-E more desirable than F-G-E) to reduce possibility of spotting across river and to protect roadside area and subsequent damage from erosion.
7. Plans on early control to guard against possibility of unexpected spread, and to allow burning out lines as completely as possible by daylight.

(e) He estimates man-power and time required as follows, figuring conservatively on output per man-hour:

1. Line A-B (40 ch.). Tractor crew of 10 men. 6 to 7:30 p.m.
   (a) Snag felling; 20 snags; 3 crews; 9 men. 6 to 8 p.m.
   (b) Backfiring; 2 men. 9 p.m. to 10:30 p.m.
   (c) Mop-up and patrol; 12 men. 9 p.m. to 6 a.m.
2. Line A-F (110 ch.). Tractor crew of 10 men. 8 p.m. to 11 p.m. (Somewhat easier going than line A-B.)
   (a) Snag felling; 55 snags; 9 men from line A-B plus 9 additional. 8:30 p.m. to 11 p.m.
   (b) Backfiring; 3 men. 9 p.m. to 11:30 p.m.
   (c) Mop-up and patrol; 25 men. 9 p.m. to 6 a.m.
3. Line B-C (40 ch.). Experienced guard and 2 men. (Guard will blaze line A-B en route.) 5 p.m. to 10 p.m.
4. Line C-D (20 ch.). 10 men will build, mop-up and hold. 7 p.m. to 6 a.m.
5. Line D-E (20 ch.). 6 men to clean up and patrol. 6 p.m. to 6 a.m.
6. Line E-F (20 ch.). 20 men will build, clean burn, mop-up and patrol. 6 p.m. to 6 a.m.

(f) He estimates the area within foregoing control lines as 450 acres.

Note: As crews, such as fallers, complete their work, they are used to supplement other crews to expedite work. Men not needed after midnight are sent to fire camp for rest. May be held until afternoon as reserve next day if needed, otherwise demobilized.

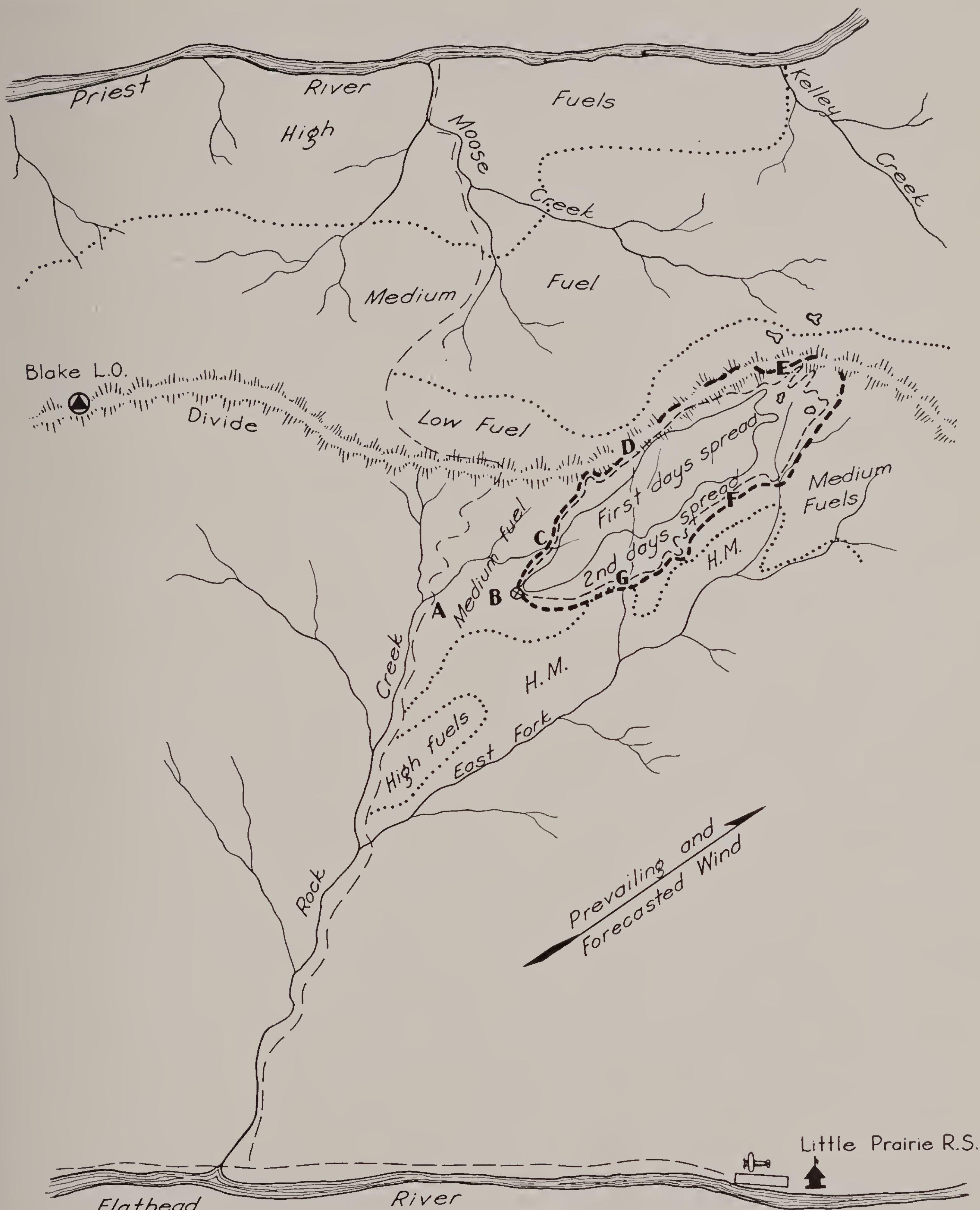
(g) Telephone dispatcher at 4:30 p.m.

1. Fire camp to be at Monroe Creek Campground.
2. Dispatch 75 CCC's as soon as fed.
3. Follow up with 25 additional CCC's to bed down at fire camp and act as reserve. If not needed during night, will go on patrol in morning.
4. Send two more guards or scouts to search for spot fires.
5. Preliminary estimate of morning requirements: to be available, ready to go on line at 4:30 a.m.; 50 CCC's; 2 foremen with leaders; 1 competent relief fire boss. Have 25 additional men prepared to come in morning if called for during night (safety measure).

Summary of Correct Practices:

1. Adequate preparatory action taken by dispatcher.
2. First crew contributes held line.
3. Ranger sizes up situation, considering all factors; decides probable rate of spread; figures suppression forces needed, sector by sector, and plans for prompt control.
   (a) Takes advantage of natural barriers.
   (b) Selects lines of greatest speed and ease to build and hold.
   (c) Selects lines with view to using machinery.
   (d) Considers all elements of the job, such as snag felling and backfiring.
   (e) Takes precautions in respect to unforeseen troubles.
4. Adequate overhead is provided.
5. Sufficient safety factors are provided in both man-power and time.
6. Correct sequence in line construction and backfiring is planned and followed.

Handling Fire in Back Country:



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Situation:

A dry lightning storm at 2:30 p.m., August 10, has started several fires in an area which is two or three days' walking distance from nearest road. Burning conditions are severe. Danger class 5 to 6 has prevailed at nearest station during previous week. (Little Prairie Ranger Station.) Weather forecast indicates scattered lightning storms with gusty winds up to 18 miles and humidity of 15 to 20% during ensuing burning period.

Dispatcher at Little Prairie has used all available men, sending what he believes insufficient man-power to several fires. He has called for extra smokechasers to be delivered by plane from adjoining forest as early as possible. Before the first load arrives at the landing field, he gets report that a new fire at head of Rock Creek has been discovered. Blake lookout reports it is spreading rapidly in strong wind.

This fire has solid fuel body ahead and uphill to main divide. Steep country. Medium fuels but exposed to wind on south slopes. Is six hours' walking distance from landing field. The divide is partially barren, open and will check running front at least temporarily.

Blake Mt. lookout-fireman is sent to fire to do what he can in event the wind drops. He is to work on spots over divide if fire reaches divide this afternoon or if it spots over from present location. No lookouts left to report on conditions.

Dispatcher radios Missoula, asking that first airplane be routed over fire on its way in. Orders fifty more men to be planed in, knowing that he will have time to move carefully, size up jobs and plan action before second load is delivered.

Calculation of Probabilities:

At 3 p.m. the dispatching officer estimates the job as follows:

Plotting the point of origin on a fuel map, he finds that the fire can burn in unbroken MM fuel uphill to the north about one mile when it will encounter low spread fuels on a high divide. Under prevailing and forecasted southwest winds it will spread diagonally uphill toward southeast in unbroken MM fuel to the divide, a possible length of three miles. Steepness of slope will cause fire to back downhill rapidly after it reaches first prong of East Fork of Rock Creek. Across this fork it will spread fast to in-curve of divide.

He estimates fire will reach the divide before the end of the burning period. Sketching this probable spread on a map, he finds that he will have some 1200 chains of fire edge by 8 p.m. Also, may have spots in Priest River drainage. This would make a job of at least 2500 man-hours by the end of the present burning period.

Knowing that the first crews will not reach the fire before 5 a.m. tomorrow, the dispatcher recognizes the impossibility of getting sufficient men on the line to gain control before the next burning period. It would require 500 men on the fire at 5 a.m.

The first plane arrives at 4:10 p.m. and observers confirm his estimate of fire spread. This load (12 men) are immediately started to fire, taking three pack animals to carry fire packs, beds and radio SPF. They are told to proceed on Rock Creek Trail to top of divide. They will arrive about 11 p.m., establish radio contact and get instructions.

The second and third loads of men are dispatched as was the first crew. All going to the top of the divide. The fourth load reaches Little Prairie just as darkness falls at 8:30 p.m. By steady night hiking they will reach point A at about two hours before

daybreak. They take lights and lunches only. Backpacks and a note of instructions will be dropped to them at point A at daybreak.

The backpacks are loaded in the plane which is grounded on account of darkness. These will be delivered as the plane goes out on first trip.

At 9:00 p.m., the dispatcher having mobilized all facilities at his command, can take no more action until he contacts the radio sent in with first crew. He has informed the supervisor's office of current action. He now refines his calculations by checking his previous estimates with the guide charts. He finds it would require 2540 man-hours to control fire before the next burning period. He assumes that the first men will begin attack at 5 a.m., leaving five hours to work before 10 a.m. To control fire by 10 a.m. would require more than 500 men on the line at 5 a.m. It cannot be done. He can have only 50 men on the fire at that time.

This means that the fire will run through the second period, and requires a recast of calculations. With wind and humidity predicted as 13 to 18 miles and 15 to 20% respectively, he anticipates the worst and estimates what the job will be at end of tomorrow's burning period. He reasons as follows:

Prevailing southwest wind will prevent rapid spread downhill to west and south, but steepness will cause fire to slide down all along south side. This will cause successive narrow runs toward east, but slope will tend to carry heads back into main fire. This behavior will, unless retarded by adequate man-power, extend fire downhill, perhaps one mile and would then be in high spread fuels. Unless stopped before reaching this belt of fuel, the fire will probably cross Rock Creek and involve both sides of the drainage. If sufficient man-power can be placed along the south side to keep fire from sliding into high fuels, the perimeter will not be greatly increased over that of its first run.

The momentum of eastward runs will be slowed up by the cross canyons at the head of Rock Creek but the fire likely will reach the main divide, probably spotting across.

The north side, along the divide should be held throughout tomorrow by hot spot crews which will reach fire early in the morning.

Therefore, action should be planned to:

1. Keep fire out of Priest River drainage.
2. Stop south side before fire reaches rapid spread fuels along lower slope. If this plan is successful, the perimeter of the fire will be increased only two hundred chains over the initial run.

This indicates a job of 1400 chains or roughly 2800 man-hours on the line.

The dispatcher knows that a large crew is needed. He considers possibilities of walking in reinforcement crews. It will require two days' walking time from the end of the motor road to the forks of Flathead River and Rock Creek. From then to the fire is another four hours' hike. At best, crews walked in would not reach the fire before the peak of the burning period, August 13. Even then they would be badly worn and the fatigue factor would greatly reduce their productiveness. He, therefore, decides to rely upon air delivery of his crews.

The dispatcher analyzes possibilities of airplane transportation and budgets the job as follows:

The fifty men delivered this afternoon, will reach fire during night, and on an average will put in twelve effective hours tomorrow—600 man-hours.

Missoula will ferry more planes from other Regions during night and should have eight planes in air by 5 a.m. tomorrow, capable of delivering 60 men each trip. A round trip takes about two hours. If men are hauled until 4 p.m., he can have 300 men trailing to fire during day. Planes must be used to drop camps and equipment from 4 p.m. until darkness falls.

These crews will put in effective time on fire as follows: (Estimating that 50 men out of each 60 will be effective line workers.)

First 60 men work fire line 1 p.m. to 7 p.m. .... 300 m.h.
Second 60 men work fire line 3 p.m. to 7 p.m. .... 200 m.h.
Third 60 men work fire line 5 p.m. to 7 p.m. .... 100 m.h.
Fourth 60 men arrive at fire 7 p.m. too late to go on fire.
Fifth 60 men arrive at fire 10 p.m. too late to go on fire.

Work on line August 11. Total effective 1200 m.h.

By the end of the August 11 attack, providing that spreading sectors have been checked as anticipated, there will remain a job of 1600 man-hours on the morning of August 12. This can be accomplished by the man-power on the fire by working 4 a.m. to 9:20 a.m.

Unless special weather forecasts indicate wind conditions far in excess of the worst normally expected, this plan of mobilization appears sound and adequate.

If additional men were ordered, they could not be delivered at Little Prairie earlier than 5:30 or 6 o'clock on the morning of August 12. Six hours' hiking is required to get them to the fire by 11:00 or 12 o'clock, two or three hours after fire should be controlled. Dispatcher, therefore, lays plan to handle fire with men delivered on August 10 and 11.

At 9:30 the ranger arrives at Little Prairie Station. Discusses action taken and checks dispatcher's calculations. Together they plan course of action and use of crews already dispatched. Ranger agrees with tentative program worked out by dispatcher and leaves to take charge of fire.

At 11:30 p.m., first crew reaching divide calls in. Can see that fire has reached divide at point D and reports spot fires in head of Moose Creek on Priest River side. Dispatcher instructs crew to eat lunch, rest an hour and proceed along divide to spot fires. Split crew if necessary and attempt to hold most dangerous spots. Send scout back to radio from first good observation point to inform dispatcher on conditions. Decision based on desire to hold fire in Rock Creek drainage. Foreman to leave note at radio on trail instructing crew number 2 to call ranger station. 12:40, crew 2 reports in. Upper north side of fire appears quiet except for few hot spots along divide.

Dispatcher instructs this crew to scatter out on hot spots from point D to E, to attempt reduction of spotting across divide. To leave note at radio instructing crew 3 to call station for orders. 3 a.m., crew 3 establishes radio contact with dispatcher. Reports fire quiet except for slight uphill runs between points C and D.

Dispatcher instructs this crew to go along divide to some place west of D where they can scatter both ways along upper reaches of line C-D. Hot spot and cold trail in attempt to prevent another run against divide which would spot over.

4:20 a.m., scout from crew 1 reports back. Spot fires in Moose Creek appear less serious than anticipated. Section D to E too much for crew 2 to hold. Section C-D fairly hot on lower end. Section B-C backing downhill.

Expecting daylight at 5 a.m., dispatcher starts plane with backpacks to be dropped to crew 4 at point A. Prepares note to be dropped; "Refer to enclosed map which indicates latest dope on fire. Take crew up ridge northwest of point A; go to point B. Concentrate effort on slowing up or stopping downhill (south and east) spread on section B-G. Give such attention to B-C as necessary to prevent fire from flanking your work on B-G. Radio will be dropped to you during forenoon Report in then for information and instructions."

Ranger checks in from divide radio at 5:30. Will direct action henceforth. Has discussed with scout from crew 1 and asks that new crews be started to point A with lunches only, as soon as possible. Will have equipment dropped. He will meet crews at point A. Instructs dispatcher to have airplane pictures of entire fire edge dropped to him at point A before noon.

Subsequent Action:

Ranger gets pictures before first reinforcements arrive. Pictures indicate all fire on north is in low spread fuels and spots in Moose Creek are quiet. Danger point is south side where fire can crawl down and make a sweep up east fork in high fuels.

As crews arrive he strengthens attack from C through B and extends line toward G-F-E.

As soon as line C-B-G is relatively safe, a camp is dropped at G to accommodate men on sectors B-G and G-F.

Another camp is dropped on divide west of D to accommodate crews on sector C-D and those working part of D-E. Bosworth Trenches dropped on line midway between B and G.

A third camp is dropped near E and crews trying to divide build down E-F and handle all spot fires from this camp.

Tactics Applied:

1. B-C direct method attack following hot spotting by first crews which has reduced heat and made this method economical. Reason: To take no chance on fire flanking C-D.
2. C-D hotspotted by initial attack. Cold trailed to place where fire edge reached semi-barrier on divide. Indirect line from there to D was burned out during favorable wind.
3. D-E all methods. Some rock slides and barren spots connected by indirect line and fired out. Spot fires extinguished: direct method.
4. E-F spread to creek in few places before reached by first crews. Spread kept ahead of crews working from F until fire reached divide. Line east from F to creek parallel method and fired out. Creek bottom east to divide indirect line along creek bottom; backfired out.

Heavy patrol kept on divide ahead of fire to pick up spot fires across divide.

Results:

First day of attack, August 11.

Spot fires in adjacent drainage controlled. Side which most threatened new drainage temporarily held by use of greater part of man-power. North side on mop-up basis at end of day.

Second day of attack, August 12.

Main attack was on south and southeast (bottom) side to prevent fire from sliding down into high fuels and making another major sweep under prevailing wind. Also spot patrol on northeast (head) catch all spots across divide and slow up some parts of main head in saddles on ridge top. Forty-four new men arrived. Not possible to get more since planes used part of day delivering camps and supplies.

Third day of attack, August 13.

Lines consolidated by some short cutting and firing out before heat of day. Fire controlled. Total men used 190.

Summary of Correct Practices:

1. Dispatcher had follow-up plan in action before bad break occurred.
2. Quick but sound size-up of job and speedy initial action.
3. Careful analysis of probabilities and recast of program to meet need of worst probable conditions. Seeing clear through.
4. Full and intelligent use of new facilities.
5. The dispatcher, regardless of whether he was the headquarters' guard or the supervisor, arose to the emergency and made use of those tools which must be used in successful fire suppression, imagination, sound judgment, aggressive action and modern equipment.

ORGANIZATION ON LARGE FIRES

Once a fire gets beyond the smokechaser stage, new problems arise in the division of duties and jobs of leaders on the line and in service of supply. There are new needs for co-ordinating effort, in obtaining information as a basis for planning and executing attack, in checking and inspecting work under way and in adapting the organization as a whole to the job to be done.

To organize most effectively for any big fire requires:

1. Clear recognition of the size of organization required, as determined by the size and complexity of the suppression job.
2. Understanding of accepted lines of authority and standard plans of organization.
3. Knowledge of the titles, responsibilities and duties of each position in big fire organization.

FIRE BOSS

Responsibility and Authority:

Is in general charge and has full authority for all action taken to suppress a fire, and is responsible to the district ranger or forest supervisor. The responsibilities and requirements of the fire boss vary with the size of the job. When only one camp is needed, and the maximum organization does not exceed two hundred men, or when the entire line job is handled as one sector, the fire boss may perform all those duties described as comprising the sector boss job.

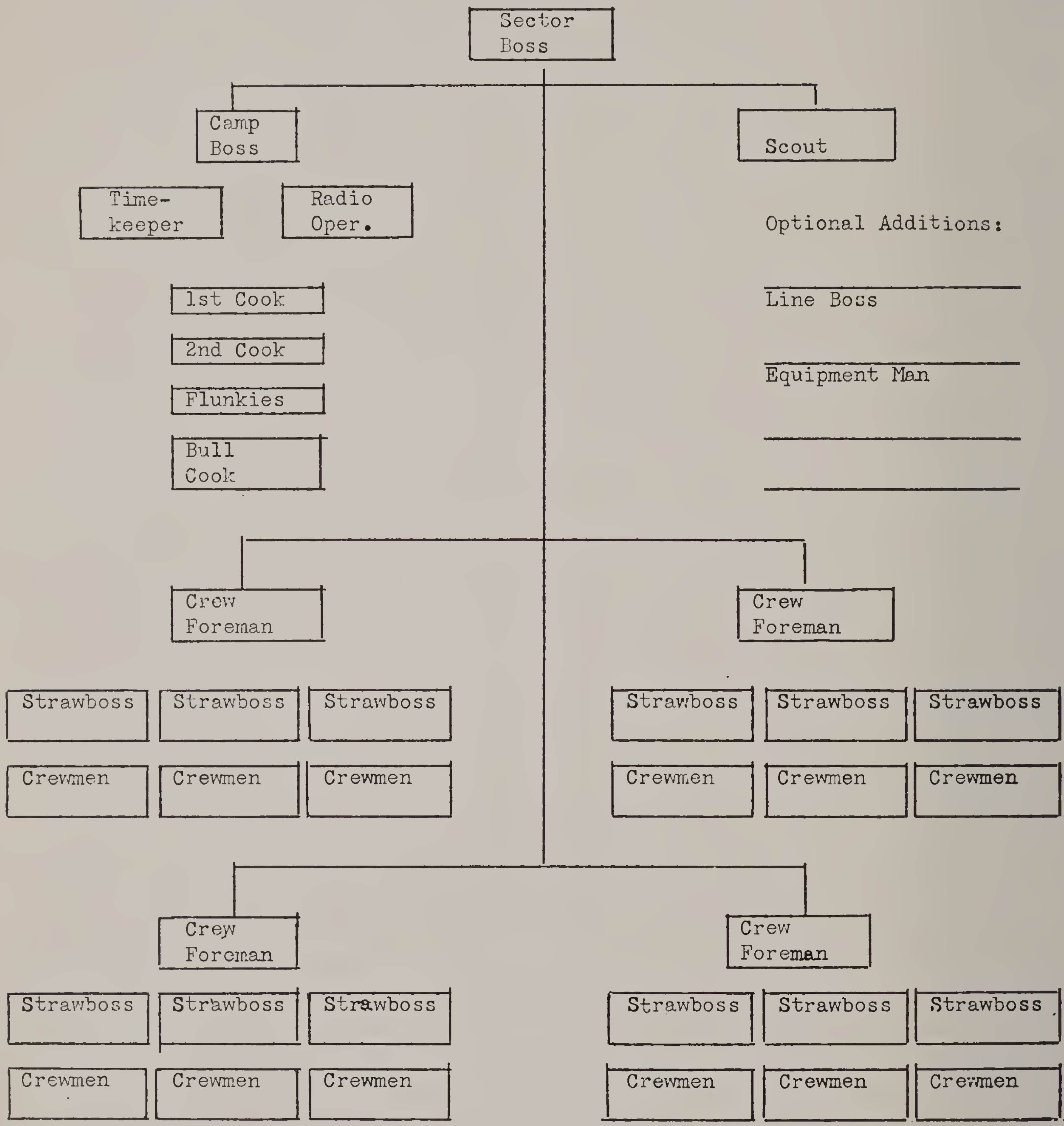
When the job is divided into more than one sector, the fire boss delegates responsibility for execution of plans to his sector bosses. If the number of sectors becomes so great that he can no longer give adequate personal attention to each, he assigns a division boss to act as his assistant in general charge of each two or more sectors. In such instances the fire boss will not deal direct with any sector boss. He will work

through division bosses. Likewise, should the number of divisions reach a point where he cannot give proper supervision to all, he establishes the position of general assistant. The assistant fire boss shares such part of the fire boss' job as may be assigned, or may act as alternate for the fire boss. Organization charts shown at the beginning of this section will indicate the normal organization procedure to be observed by the fire boss, depending upon load variation and complexity of the job to be done.

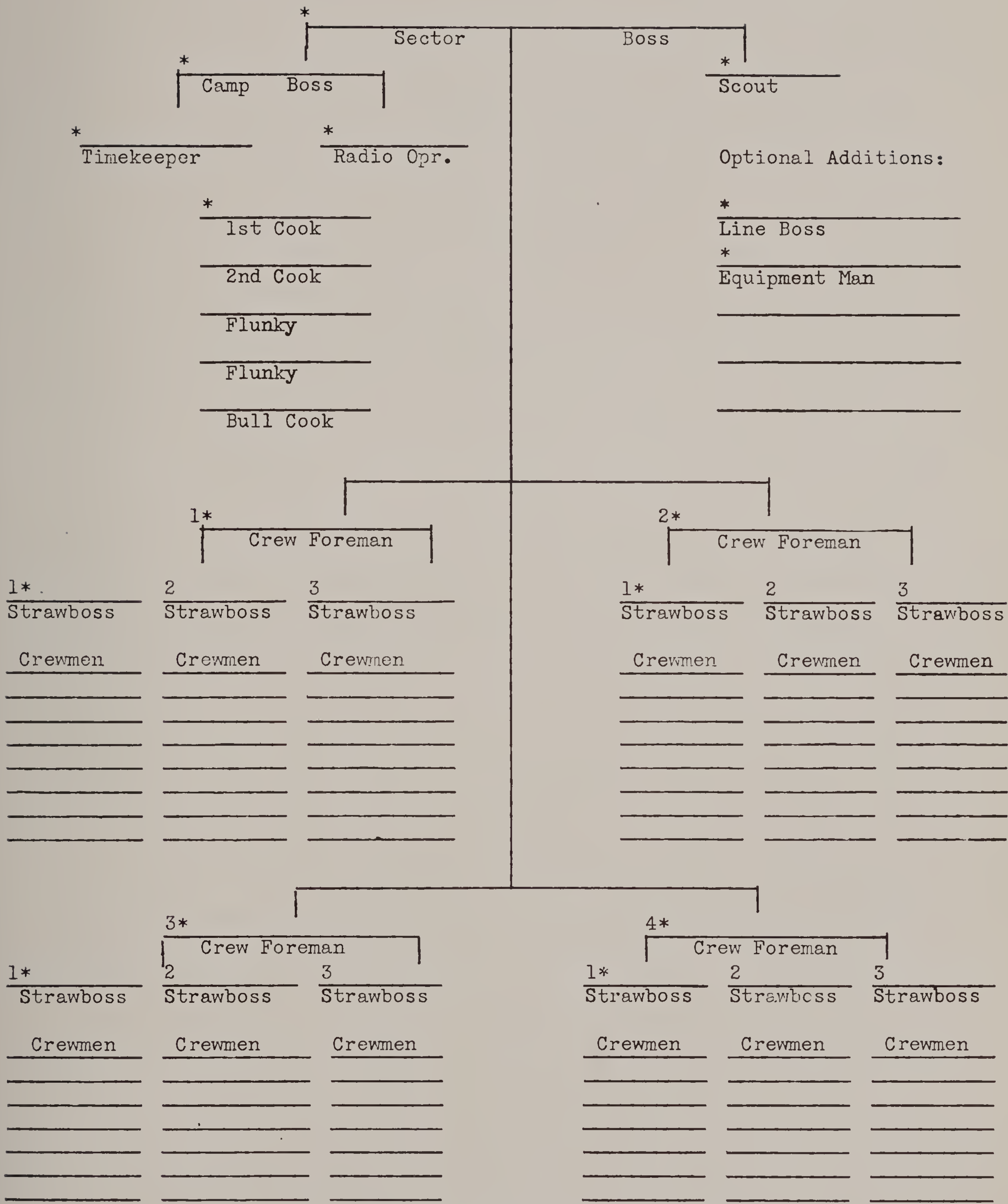
Jobs:

1. *Reconnaissance.* Initiates steps to establish scouting service that will give him full current information on the physical and climatological conditions on each sector and spot fire area, the location of possible control lines, the spread of the fire and the progress of control measures. He covers as much of the actual fire line as he can to see conditions for himself. On sector stage fires he can generally spend considerable time away from communication; on division stage fires he must keep in communication, except for short periods during lulls. He should use airplane photographs to the full extent necessary to supplement information otherwise available. The fire boss should do little or no actual scouting. He has a bigger job to do.
2. *Strategy.* Formulates plan of action to control fires before the start of the next burning period, and issues orders to secure what is needed within suitable time limits to carry out his plan.
   As conditions require convenes sector bosses and division bosses to revise plans.
3. *Tactics.* Determines methods to carry out plan of action.
4. *Organization.* Assigns specific jobs as required by the size of the suppression job to designated officers, with due regard to qualifications. Assigns sectors and divisions and organizes base camp.
5. *Camp Locations.* Determines where these will be, and designates headquarters camp, supply bases, etc.
6. *Inspection.* Spends sufficient time on line to check on performance of subordinates and execution of plans. Delegates much responsibility for inspection to division bosses or his assistant on larger fires. By cross section inspection makes certain that each phase of the job is conducted according to outstanding instructions.
7. *Training.* Grasps every opportunity to further the training and experience of subordinate officers. May over-man certain phases of the job to accomplish this, if so requested by the supervisor.
8. *Personnel.* Maintains notes and acquires information necessary to make report on performance of all officers ranking from assistant fire boss to sector boss inclusive. Fire boss may accept division boss' reports for those ranking below that station, but should check or review all before submitting. (Forms for such reports are included in all timekeeper kits, and must be filled in and submitted to supervisor.)
9. *Reports.* Assembles daily reports from sector bosses, combines into complete report for fire and transmits to supervisor or ranger headquarters not later than 9 p.m. each day. In transmitting this report by telephone or radio, it is not necessary that the full description of each caption be stated. Time will be saved by identifying captions by symbols shown on left margin of report form; as, A—Pete King; F—860; H—CCC—80; FF—642; Guards—7; Forest Officers—16. Sample Form—(Forms furnished in timekeeper kits).

SECTOR ORGANIZATION CHART.



SECTOR ORGANIZATION CHART.



(See Instructions on back of this sheet.)

(Back of "Sector Organization Chart" sheet)

INSTRUCTIONS FOR USE OF FORM

Each organized overhead squad will include the following positions: (Positions starred on outline.)

1 Sector Boss.
1 Camp Boss.
1 Scout.
1 Timekeeper.
1 Radio Operator.
4 Crew Foremen.
4 Strawbosses.
1 Cook.

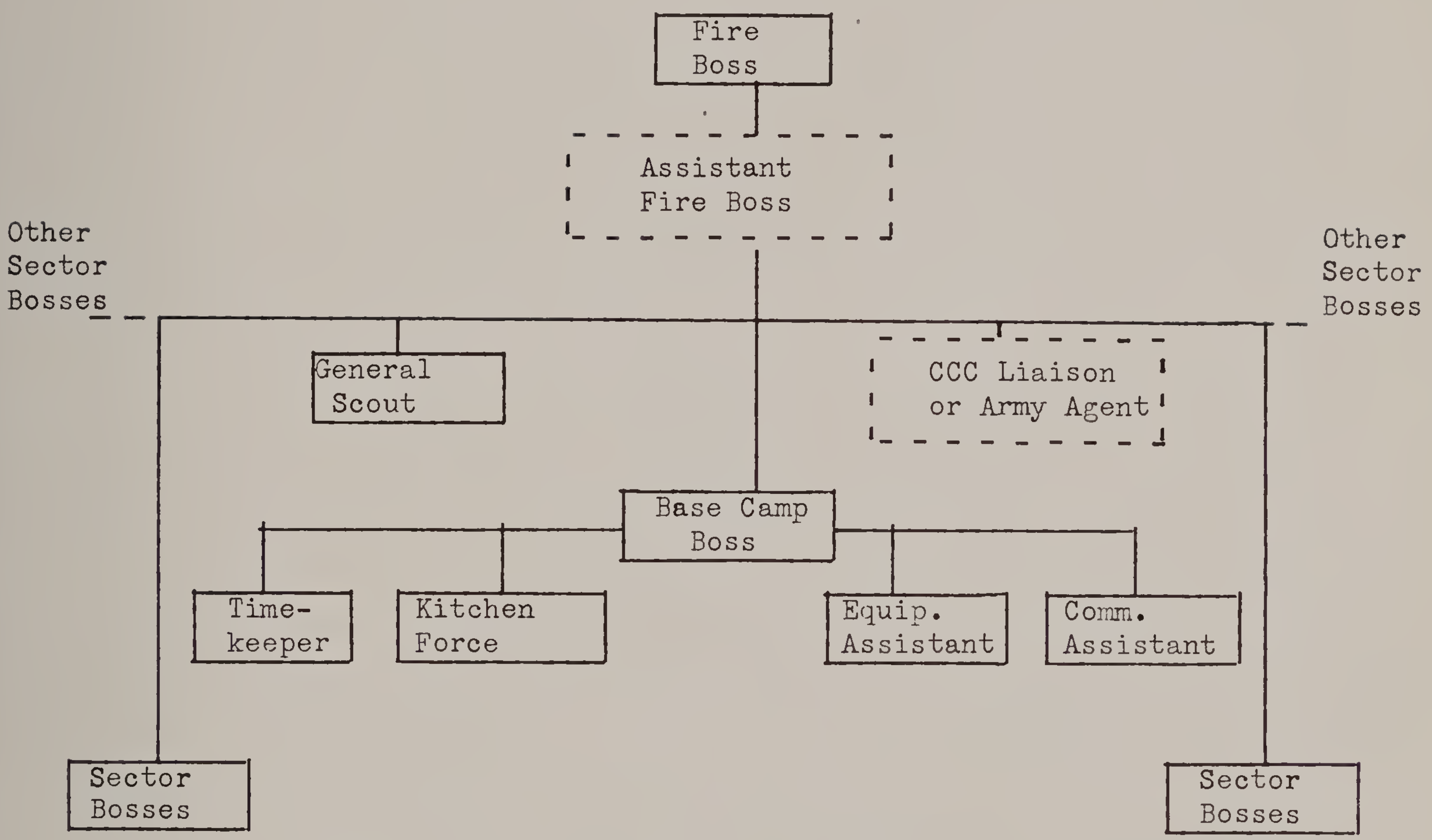
Organization on the job will necessitate selecting the following additional positions from crew members or other sources outside the preorganized unit:

8 Strawbosses.
81 Crewmen.
1 Cook.
2 Flunkies.
1 Bull Cook.

Extra positions established on the job (messengers, etc.), if any, will be indicated in the blank spaces on the right margin of the sheet. This sheet completely filled out (excepting crewmen) will be furnished to each foreman, camp boss and timekeeper.

The crew foreman will provide each of his strawbosses with a sheet showing the foreman's name and the name of the strawboss and the members of his squad.

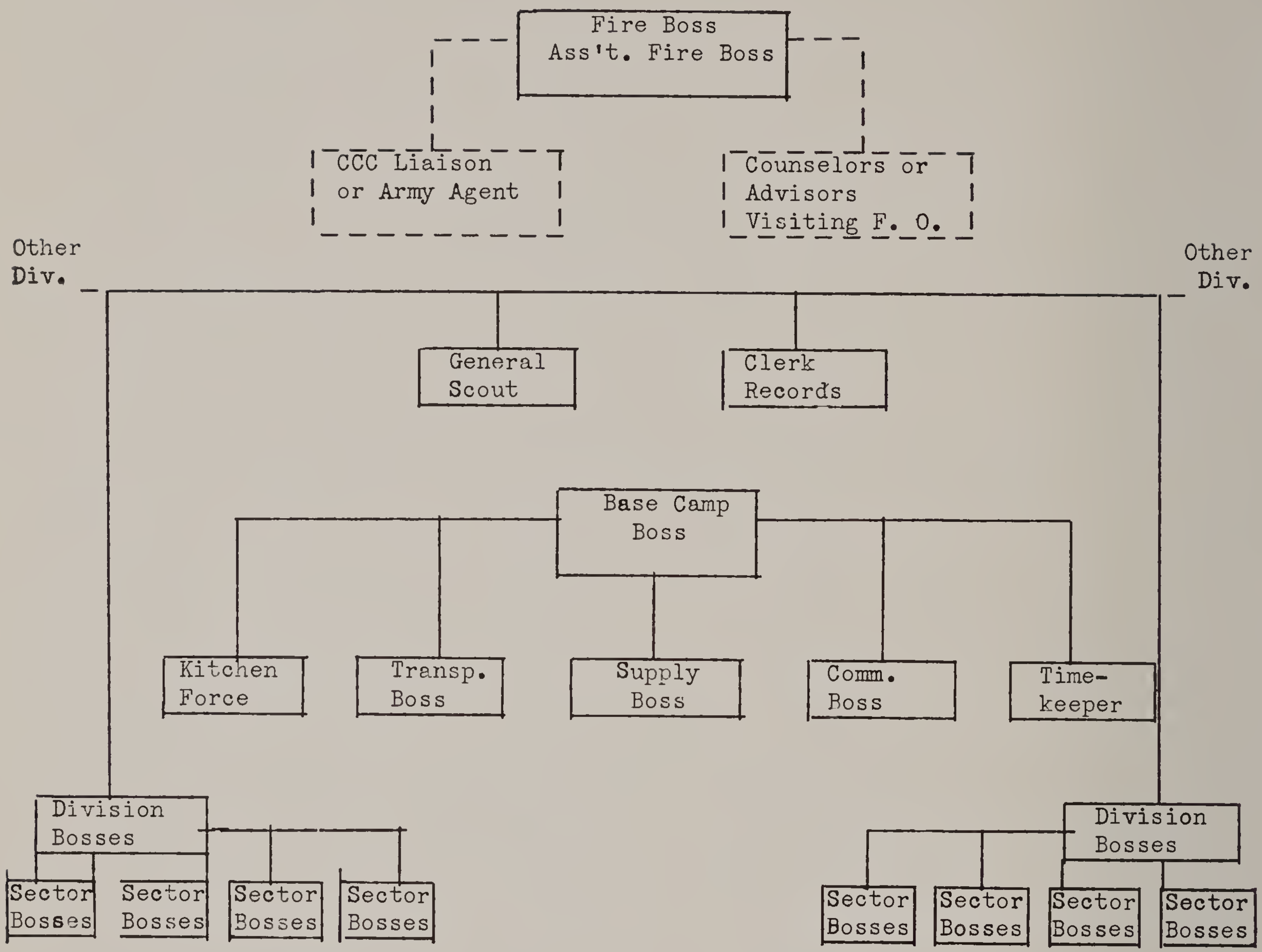
ORGANIZATION CHART.
SECTOR STAGE FIRE.



The sector stage organization as shown is normally adequate for management of fires involving not more than four sectors. Positions of "assistant fire boss" will be used when necessary on account of unusual problems which require more fire boss caliber work than is reasonably possible by one man. Position of "Liaison Officer" is necessary only in those instances where problems of managing large crews of CCC enrollees require the attention of a special CCC officer.

When more than six sectors are established, or when difficulty of administration warrant, the fire boss will set up a division state organization.

ORGANIZATION CHART.
DIVISION STAGE FIRE.



The division stage organization is established to manage fires having four or more sectors. The complexity of the job will determine the number of sectors comprising a division. Normally not more than four sectors should be assigned to one division boss.

Positions attached to the base camp boss job may be combined when the volume of work permits. The CCC liaison officer may be required on few or many fires, depending upon the amount of time necessary to conduct CCC matters.

The positions of "Counselor or Advisor" is established to provide a definite station for seasoned experts, and men of long experience and valuable fire knowledge, who for any reason cannot take active part in suppression duties. This position carries no authority and incumbents will act only as consultants to the fire boss. Advisors will not issue instructions to line officials below the rank of fire boss.

FOR EACH CLASS C FIRE

Report the following information to Missoula each day until Class C, D and E fires are controlled. The information should reach the supervisor's office each evening not later than 8 p.m.

A. Name of fire ....
B. Location: Sec.............................. T.............................. R..............................
C. Cause ....
D. Areas...acres.
E. Estimated perimeter...chains.
F. Length of held line...chains.
G. Length of line to build...chains.
H. Number of men actually on line: CCC.............................. FF..............................
I. Additional man-power planned..
J. Estimated time of control..
K. Perimeter at time of control..
L. *Estimated cost to control..
M. *Estimated damage ....
N. *Timber burned ....
O. Special features (loss of lives, property, etc.)..

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(Fire Boss)

* Captions L. M. N. to be filled in by supervisor's office.

ASSISTANT FIRE BOSS

Is used when the number of divisions becomes so great as to prevent adequate correlation and supervision of divisions by the fire boss, or occasionally is used as alternate to the fire boss on jobs of great complexity or exceptional physical hardship.

Responsibility and Authority:

Checks performance on plans of action; sees that all parts of job progress properly; takes immediate action to remedy discovery failures or deficiencies and reports action to fire boss. In emergency conditions modifies (in writing) previous plans and orders of the fire boss. In general does trouble shooting for fire boss on the line. Alternates with fire boss if necessary. Is responsible directly to fire boss (when acting as assistant).

Jobs:

Checks to determine if:

1. Best methods of firefighting are being used.
2. Adequate overhead and man-power for all jobs is available.
3. Sufficient and correct tools and equipment are on hand.

4. Line units are correlated with adjacent units.
5. Suitable standards are followed as to line location, line construction, mop-up and patrol.
6. Line output is adequate under existing conditions.
7. Job as a whole is progressing satisfactorily.
8. Camps are functioning properly.
9. Service of supply is adequate.
10. Possibilities exist for using machinery.
11. Required records are kept.
12. Critical situations are being handled properly; aids in immediate planning for such situations as becomes necessary.
    In addition he:
13. Does other jobs on assignment from fire boss.
14. Is prepared to sit in as a member of the fire bosses' daily planning conferences.
15. Functions on line for fire boss when size of fire requires that fire boss remain in constant communication at base camp.
16. Assists fire boss in matters of organization and personnel, including the making or checking of performance reports for division and sector bosses and base camp personnel.

SUPPLY BOSS

Responsibility and Authority:

Supplies all food, tools, equipment and commissary needed when the size of the job makes it necessary for the fire boss to turn over these duties to a specially appointed man. Reports to fire boss.

Jobs:

1. Anticipates needs of all fire camps and prepares plans for service of supply. Stocks supplies on basis of 24-hour need.
2. Makes all prearrangements for prompt ordering, delivery and distribution of supplies and equipment.
3. Collects and correlates orders from all fire camps for tools, commissary supplies and equipment. Fills orders to extent possible from stocks on hand, ordering additional supplies through proper channels when necessary. Holds camps to 24-hour limit on supplies.
4. Sees that camp bosses anticipate needs for tools and equipment and submit orders promptly; maintains adequate stock to meet needs; knows of surpluses and arranges for transfer.
5. Sees that camp bosses anticipate needs and place orders for subsistence supplies before 3 p.m. Determines if quantity is adequate and not excess. Guards against excesses in supplies at all times.
6. When necessary to purchase supplies locally, secures approval of fire boss and procures in accordance with established procedure.
7. Maintains current inventory record of all tools and equipment, showing their location.
8. Sees that invoices are checked and record maintained of incoming subsistence and other supplies and their distribution.

9. Maintains other records as required.
10. Directs reconditioning and maintenance of equipment held for use and assembles excesses for immediate return to central warehouses.
11. Secures help from fire boss as needed.

TRANSPORTATION BOSS

Responsibility and Authority:

Provides and maintains all transportation facilities needed on the fire when the size of the fire job requires the fire boss to turn over these duties to a specially appointed man. Reports to fire boss.

Jobs:

1. Obtains transportation needs for all fire camps. Makes plans and prearrangements for securing same.
2. Collects requisitions for transportation facilities and supplies (gas, oil, parts, grease, forage, etc.); makes adjustments between camps where possible; orders through proper channels.
3. Decides disposition of equipment requiring major repairs; makes arrangements for replacements where necessary.
4. Obtains special equipment, such as tank trucks, trail builders, tractors, graders, pack and saddle stock when requested by the fire boss.
5. Provides for inspection of mechanical condition of automotive equipment and for minor adjustments and repairs; inspects for proper functioning of all transportation personnel and equipment; inspects for compliance with safety requirements; inspects condition of animals and equipment, and forage supply; maintains written record and file of inspection.
6. Maintains record of location of each piece of equipment and various items of supplies; records of use; records of gas and oil consumption; records use of rented trucks and animals to be turned in to fire boss. Maintains time or mileage records for hired stock or machines.
7. Sees that routes of travel used are posted with direction signs.
8. Sees that routes of travel are kept open and passable, or rerouting set up if conditions require.
9. Establishes traffic controls where needed to prevent congestion or accidents.

BASE CAMP BOSS

Responsibility and Authority:

The incumbent will combine the responsibilities and authority of both supply boss and transportation boss. In addition he will be in charge of communication and operation of the base camp. His duties as manager of the camp will be governed by instructions for "Camp Boss" described elsewhere in this book.

SCOUT

Responsibility and Authority:

Scouting is divided into two distinctly different types of jobs; both are equally important but serve different purposes. Scouting of either type is done for the purpose of providing the information necessary for planning and management of attack. Success of attack is wholly dependent upon the accuracy and completeness of scout reports.

GENERAL SCOUT

Responsibility and Authority:

The general scout operates under the direction of the fire boss. He is responsible for obtaining general information on the location, condition, progress and behavior of the whole fire, or such parts of the fire as requested by the fire boss. Information required may be of a broad nature, omitting much of the minor details which are left for sector scouts to investigate. The general scout provides an over-all picture or description of the fire from which the fire boss may plan his strategy and tactics.

Jobs:

1. Obtains and delivers to the fire boss at the earliest possible moment, a map indicating:
   (a) General location of fire perimeter.
   (b) Location of spot fire problems.
   (c) Behavior of fire on all units of perimeter.
   (d) Major changes in fuel type, topography or other factors adjacent to the fire's edge.
   (e) Possible means of access to fire's edge.
   (f) Possible camp sites.
2. As directed by fire boss he will:
   (a) Guide sector units to location selected by fire boss, or mark such routes with signs.
   (b) Investigate specific areas of fire or certain spot fires ahead of control crews and submit estimate of needs.
   (c) Establish and maintain such means as necessary to keep fire boss advised of current fire behavior and status of control.
   (d) In unusual instances may coordinate and direct work of assistants.
3. To expedite transmission of his observations for the field to fire headquarters he should:
   (a) Make full use of portable radio sets, either operating set himself or by taking skilled operator and equipment with him on reconnaissance trips. Use portable telephone where possible.
   (b) Where radio not available, or for some reason not practicable, use messengers and written messages. Never verbal.
   (c) On large fires where other means too time-consuming, use airplane for initial scouting. Have airplane pictures of fire edge and adjacent area dropped at designated locations. (See instructions for marked delivery site.)

SECTOR SCOUT

Responsibility and Authority:

The sector scout is a member of the standard Region One sector overhead squad, and is responsible to the sector boss. He obtains full detailed information on location, condition, progress and behavior of all fire within and adjacent to his territorial assignment as requested by the sector boss.

Jobs:

1. Usually proceeds to sector ahead of control crews, marks route with signs or blazes as necessary. If acquainted with area, may guide crews to sector.

2. Scouts ahead of control crews, determining, mapping in detail and reporting to sector boss:
   (a) The location and behavior of fire edge within assigned sector.
   (b) Location, size, behavior and potentialities of spot fires.
   (c) Fuel types or characteristics in and adjacent to fire edge and at spot fires.
   (d) Possible routes to various parts of fire edge and spots.
   (e) Major changes in fuel, topography, exposures, etc., near enough fire's edge to influence tactics.
   (f) Locate and mark water chances within reach of probable fire line.

3. Upon request of sector boss will:
   (a) Locate line ahead of crews.
   (b) Mark routes to spot fires.
   (c) Search out, develop and mark water places for use by water bucks.
   (d) Act as messenger.
   (e) Maintain contact with adjoining sectors.
   (f) Keeps up-to-date map of control progress and assists sector boss in obtaining line data for daily reports.
   (g) Take charge of and direct small crews on spot fires or hot-spotting operation.

DIVISION BOSS

Responsibility and Authority:

When the number of sectors on a fire becomes too great to permit adequate supervision by the fire boss, he will designate qualified officers to act as his assistants, each in general charge of two or more sectors. Normally divisions will not be established when less than six sectors are in operation. Such assistants are division bosses and each is in general charge and has full authority to make and execute detailed plans for the control of a division of a fire. These plans are in keeping with the general plan made by the fire boss for controlling the entire fire. He reports to the fire boss. He supervises and coordinates the work of sector bosses within his division.

Jobs:

1. Obtains and checks to be sure he understands the written instructions from fire boss on:
   (a) General plan of action for division and correlation with adjoining divisions.
   (b) Location and boundary of division.
   (c) Camp locations planned.

2. Secures from fire boss for his division:
   (a) Names and qualifications of overhead assigned
   (b) Man-power on job and that ordered to come in.
   (c) Special equipment available.
   (d) Transportation on hand to move men and horses for riding or packing if needed; best routes of travel.
   (e) Best map available.
   (f) Weather reports currently, and transmits these to sector bosses.

3. Discusses and outlines work planned on each definitely designated sector with boss to whom each is assigned. Confirms instructions in writing.

4. Checks in communication needed to facilitate work in division and places orders for required installations.

5. Anticipates need for special equipment and additional man-power, etc., and places advance orders so that they will be available when required.
6. Inspects in detail, progress and quality of work on his division at least once each day and applies corrective action promptly when needed.
7. Studies fire behavior and recommends to fire boss changes in plan of action to meet changed conditions.
8. Keeps fire boss informed currently in detail of developments on division.
9. Keeps in touch with adjacent division bosses to unify work program.
10. Sees that sector bosses turn in information necessary for evening reports. Collects this information, assembles it into one report for his division and transmits to fire boss.
11. Discusses division plans for each day with sector bosses and secures their cooperation in meeting them.
12. Attends daily conference called by fire boss to plan action for ensuing day.

SECTOR BOSS

Responsibility and Authority:

When the perimeter of a fire reaches a length so great that the fire boss can no longer give adequate personal supervision to all units of line organization, he assigns management of each part requiring operation of 100 or more men to a sector boss. Likewise, when complexity of the job, as well as volume of work requires supervision, above the level of foreman, a sector boss is assigned. Usually a sector boss will be placed in full charge of each part of the fire perimeter requiring the establishment of a camp or camps. Each camp or unit requiring operation of crews totaling 100 men or more, will be set up as a sector. Seldom should one sector boss be responsible for supervision of more than 250 men.

The sector boss is in charge of all activities connected with his camp and sector and is responsible to the fire boss. On very large fires when a division boss has been assigned charge of several sectors, the sector boss will be accountable to the division boss. His duties on his sector are similar to those of the fire boss on the whole fire. He shall assist in the initial action and in getting men speedily to the fire. He must be familiar with the instructions applying to camp boss, foreman and strawboss as set forth in this book.

Jobs:

1. *Before leaving for a fire the sector boss must obtain the following information:*

    Fire boundaries outlined on the best available map.
    Weather data and latest forecasts.
    Fuel type map covering the area if readily available.
    Length of perimeter of fire.
    Character of topography.
    Forest cover and type.
    Possible camp sites.
    Kind of equipment needed and available.
    Plans for man-power on his sector.
    Plans for trenchers, plows, pumps, tractors, etc.
    Best route to fire and plans for marking route.
    Names and qualifications of overhead under his direction and general organization plan for fire.

Plans for communication, including radio operators.
Latest lookout report on conditions on sector.

2. *When starting to the fire he will:*

See that transportation is available for men, supplies and equipment.
Make sure that such essentials as tools, equipment and food supplies (including lunches) are given priority of transportation.
Start ahead of men if possible.
Provide rapid transportation for fire scouts to arrive ahead or among the first to work his sector.
Dispatch scouts over sector immediately if not already scouted.
Instruct scouts as to information he needs.
If radios are to be used, get operators and instruments working on job immediately.
Pick and instruct guides to lead crews; strawbosses to trail them.
See that no one smokes except at camps, fag stations, habitations or within fire line.
Have foremen and strawbosses distributed in trucks with their men.
Hasten departure of men to line in every way.
Arrive with camp boss ahead of crew.

3. *Arriving at sector he shall:*

Size up fire from best vantage points available, or consult with scouts, and decide on plan of attack.
Put men to work on line as soon as possible.
Instruct camp boss as to camp site and preparation.
Assign camp boss necessary camp detail of men and dispatch remainder to fire, tooled and lunched.
Camp in most strategic location regardless of water supply.
Provide for hauling or packing water if necessary.
Assign sectors to foreman and crews with complete instructions.
Distribute men as condition of fire warrants.
Have thorough search made for spot fires. Man them promptly.
Plan systematic scouting.
Get report of essential facts to headquarters as soon as practicable.
From his own observations and reports of scouts, recalculate size of control job.
Order additional men and equipment if needed.
Rearrange fire crews as occasion requires and co-ordinate action.

4. *When taking over a fire from a predecessor the sector boss shall:*

Obtain a map showing the location of its perimeter.
Get information regarding the line constructed, mopped up, built but not mopped up, amount and location of unbuilt line and the danger spots.
Calculate the size of the job remaining.
Check co-ordination of camp and line organization.
Put into effect his best plan for completing the job.

5. *Organization at fire:*

The place of the sector boss is on the fire line directing the attack, improving the tactics and technique, and assuring himself that the planned-for progress is being accomplished. His organization should permit his spending 90% of his work time planning, co-ordinating and directing fire suppression work on the fire line.

6. *Performance on the fire line:*

Delegate as much authority to subordinates as practicable.

Obtain such assistants as line foremen if size of job warrants.

Leave camp boss in charge of camp activities.

Inform timekeepers, tool sharpeners, packers, truck drivers, cooks and their helpers that they are under the direction of the camp boss.

Make it a rule to give subordinates definite written instructions.

Use messengers and do no errand running himself. Have portable radio and operator on fire line.

Assign at least one foreman and two strawbosses to each 25-man crew. (Four strawbosses is better.) Follow regional crew organization plan.

Take time to explain and demonstrate to foreman and strawbosses the plan of attack and the methods of handling men and of firefighting which are to be used.

Instruct and assist strawbosses and foremen in distributing men around the fire.

See that foremen and strawbosses maintain the correct distribution given them.

Check methods and performance of subordinates frequently and correct errors and failures. Inspect all line activities at least twice each day.

Be on the fire line at the site of greatest action. Don't scout away from crews. Let the scout do that job.

Be on most critical part of line during peak of burning period.

Co-ordinate work between crews and adjust assignments as circumstances change. Make all changes of assignment specific by designating territorial units with signs or marks.

Assign agitators to camp detail in the morning. Have time slips and transportation ready and have them discharged after crews have left camp.

Prevent discharged agitators from conversing with crews and see that they are sent to town as soon as discharged.

Have foremen and strawbosses instruct their men on the line in the technique to be used.

Be constantly alert for opportunities and use trenchers, power pumps, plows, tractors and other special equipment where distinctly advantageous over other methods.

Get strawbosses, foremen and camp boss together early each night.

Discuss and decide on the following for the next day:

1. Reassignment of crews.
2. Equipment.
3. Changes in tactics.
4. Lunching arrangements.
5. Arrangement of day shifts.
6. Night crew assignments if used.
7. Special mop-up crews.
8. Use of special equipment.

Plan next day's work and issue written instructions so every foreman and strawboss can start out next morning without delay or interference.

Have foremen arrange bedding down of their crews and know where to find each of their men at any time.

Know where to find each foreman at night.

Make foremen responsible for getting men out in the morning at time agreed upon.

Have foremen check their men out and in to timekeeper; inform him as to rate applying.

Work men not over 12 hours per day except in emergencies.

Provide for relief shifts if men are needed longer on line or mop-up work.

Reduce hours to ten per day on mop-up.

See that camp is kept clean and sanitary.

Keep posted on fire weather reports and make every possible use of them.

Keep a daily record of important messages and fire action.

Observe and enforce any smoking rules in effect.

See that all injuries receive prompt and necessary attention.

Save his physical energy by using saddle horse when possible.

Reduce force consistent with safety when fire is controlled.

Sign or authorize camp boss to sign time slips.

Obtain fire boss' advance approval of release of crews.

Have fire boss' advance approval before leaving fire.

Make report in following form to fire boss as early as possible each evening (should be before 8 p.m.).

Forms as described above will be provided in all timekeeper kits. The sector boss will fill in one report for each day. In reporting by telephone or radio he need not read or report the entire heading of each caption. Merely report data by caption symbol as E, number of chains; H, CCC—175; FF, 18, FO, 4; Others, 6; etc. The base camp will use similar forms for recording the report. Such practice can save time on crowded air and line channels.

SECTOR BOSS DAILY REPORT

(Submit to fire boss before 8 p.m.)

E. Total perimeter of fire on this sector..chains.

F. Line built and held to date..chains.

G. Estimated line to be built..chains.

H. Number of men on line today. CCC.............................. FF..............................

F.O.............................. Guards ....

J. Estimated time of control. Hour........................ a.m. / p.m. Date....................................

O. Remarks concerning special features..

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(Signed)..

Sector Boss.

CAMP BOSS

Responsibility and Authority:

The camp boss is directly responsible to the sector boss, or if stationed at the base of supply remote from the fire, to the district ranger or other designated officer. His duties are a combination of clerical and administrative work. He should, as far as possible, relieve the sector boss or fire boss of all duties regarding camp set-up, orders for supplies, men and equipment, care of equipment, feeding, timekeeping, compensation for injury cases, communication and transportation.

Jobs:

1. Provides transportation for men, supplies and equipment.
2. Setting up camp according to the plan and location directed by the officer in charge.
3. Organizes the staff set-up necessary to handle the various jobs in connection with camp operation.
4. Issuing necessary orders and instructions and supervising work of cooks, timekeepers, tool sharpeners, truck drivers, packers, communication men and others placed under his supervision.
5. Ordering men, supplies and equipment as directed by the sector boss or other officer under whose direction he is working.
6. Establish, as soon as possible, communication with headquarters and other camps or parts of the line.
7. Keep communication channels functioning, messages recorded and brought to the attention of the right persons.

7a. Receive and post fire weather reports and forecasts and see that fire boss gets them promptly.

8. Obtain men for camp detail, including messenger service, etc., and direct their work.
9. Take charge of setting up fire camp. (Refer to charts and instructions for fire camps.)
10. Arrange for car and truck parking. Keep drivers with trucks.
11. Locate stable well away from camp, below water supply and down wind.
12. Initiates an inventory of all supplies and equipment in camp.
13. See that serving tables are set up according to T-shaped or L-shaped plan to provide for double line feeding.
14. Learn when the first meal is needed and the number of men to be fed.
15. Furnishes this information to cooks and checks to make sure that the meal is being prepared.
16. See that men are fed, equipped, checked and in readiness for line duty as required.
17. Have all water bags soaked ready for use.
18. Have garbage holes dug and toilets constructed at least 100 feet from camp, road or trail and below water supply and down wind from camp.
19. Have toilets and garbage pits sprinkled with lime daily.
20. Rope or fence off kitchen and office quarters.
21. Provide for warm-up fires away from kitchen on cold nights and mornings.
22. Have canvas on hand for extra shelter in case of stormy weather.

23. See that kitchen is neat, orderly and convenient; supplies off the ground and protected from weather.
24. Have double lunches prepared and sacked as required.
25. See that cooks provide appetizing and sufficient lunches. Insist on variety.
26. See that there is no undue waste of supplies from any cause.
27. Instruct cook in best use of Fire Camp Cook Book.
28. See that sufficient supply of cooking wood is maintained.
29. Check food supply orders and cut out items not on standard supply lists.
30. Replenish food supplies from open stock lists; not with boxed unit rations.
30a. Prompt recording of all receipts and issue of supplies.
31. See that soapy dishes are well rinsed by two dippings in hot water.
32. Have tool sharpener keep extra saws, axes and other tools sharp and ready for the fire line.
33. See that tools are placed in racks labeled with number of crew and name of foreman.
34. Check timekeeper's records for conformity to existing instructions.
35. See that bedding is carefully stored, checked out and accounted for.
36. Designate sleeping areas and make assignments.
37. Have men roll, mark, check in and stack their beds each morning as they get up.
38. Keep headlights and caps locked up, charge them out and check them in.
39. Care for medicine kits and issue contents as needed.
40. See that Forms CA-1 and CA-2, complete with proper witness statements, are made up for all injuries.
41. Provide personal commissary for men and see that timekeeper issues and charges it.
42. Settle all time disputes at camp and approve time slips for all men released.
43. Inform ranger headquarters of number of men released and their destination.
44. Instruct and check timekeeper regarding daily record of perimeter, area and held line of fire and number of men working, and phone these data to ranger headquarters each evening.
45. Schedule trucks; see that they keep excess equipment hauled from camp on return trip.
46. Keep supply of gas and oil for trucks at camp. Keep motor equipment serviced.
47. When pasture is used, require packers to wrangle stock at daylight.
48. See that sufficient supply of dry feed is on hand (when used) and that it is not wasted.
49. Require pack trains to go out with full unit loads; maintain schedule.
50. See that all lights are ready for use.
51. Keep in touch with fire boss regarding camp moving, tools, equipment and supplies, stock to be maintained and orders to be sent out.
52. Sit in on evening planning of next day's fire action.
53. Keep posted on crew placements and progress of fire.
54. Breaks camp and sees that it is properly cleaned up.
55. Sees that all tools and equipment are returned to proper destinations.

TIMEKEEPER

Responsibility and Authority:

A timekeeper will be assigned only to camps of 25 men or over. In very large camps he may have one or more assistants. The timekeeper acts as camp clerk and under the direction of the camp boss will assist in keeping the camp up to the standards required in instructions under "Camp Boss."

Jobs:

1. Take up contract of each firefighter entering camp.
2. Enter on time slip Form 40 R-1, name in full, address, place hired, contract number, rate per hour, travel time allowed and classification or position.
3. Date and sign contract and return to employee.
4. Enter on time slip daily hours worked by each man.
5. Use carbon paper and make duplicate of time slip in every instance.
6. Establish station along the trail in the morning and check the hour each man leaves camp.
7. Check the hour each man returns to camp in the same manner, or through the foreman.
8. Report to camp boss any difficulties encountered or questionable time reports.
9. Check men by name and contract number.
10. Check with foreman on stragglers and men left to watch fire.
11. Allow no overtime for men hired on a daily or monthly basis.
12. Enter commissary charges on time slip daily.
13. See that commissary supply needs are called to the attention of the camp boss and ordered with his approval.
14. Accounting for all commissary consigned to his camp.
15. Do not accept cash payment for commissary.
16. Issuing beds and all property unless special equipment man is assigned.
17. Gathering information from foremen and keeping a progress map and daily record showing perimeter, area and held line of fire or sector, number of men working, etc., and phoning these data each evening to ranger headquarters or headquarters fire camp after check by fire boss or sector boss.
18. Acts as telephone or radio operator and as messenger when necessary.
19. Obtain weather reports and forecasts and see that the sector boss gets them promptly.
20. Order food supplies needed by the cook after the camp boss has checked and approved the order.
21. Check and record mileages of cars or trucks hired on mileage basis.
22. Record speedometer readings of hired trucks at beginning of fire work and keep a record of the mileage chargeable to the fire by trips and dates.
23. Start "Horse and Mule Time Slip" for each hired animal on the fire and record the time worked daily.
24. Keep commissary, medicines, and special equipment such as headlights under lock and key and charge out when issued.
25. Become familiar with compensation for injury procedure from instructions in timekeeper's kit.

26. See that CA-1 is filled out and signed by the injured man.
27. Obtain data for Form CA-2 and fill it out including signed witness statements and present it to a forest officer for signature.
28. Settle all time and payment disputes with the employee before he leaves camp. To minimize these disputes:
    (a) Study the conditions of the contracts until thoroughly conversant with them.
    (b) See that a discharged employee is frankly informed of the reason for discharge.
    (c) Hold strictly to the terms of the contract.
    (d) Provide for checks on all entries and computations on time slips.
    (e) Get foreman's note of the hour when any change in position involving a different rate of pay is authorized.
    (f) Designate only the point of hire for return transportation unless transportation is desired to an intermediate point on the same route of travel.
    (g) Allow eight hours per day only for travel by train or auto.
    (h) Allow actual necessary foot travel time in addition to above.
    (i) A day is from midnight to midnight.
    (j) Turn a deaf ear to the individual who attempts to talk you into giving additional hours, travel time or other advantages.
    (k) Refer any matters not settled satisfactorily to the camp boss.
29. When men quit or are released, have camp boss decide what travel time should be allowed.
30. If men quit or are discharged as disciplinarian action, after having worked ten days but less than 20 days, they shall be allowed travel time from point of hire to fire.
31. If 20 or more days have been worked, payee will be allowed travel and transportation from point of hire to fire, and return travel and transportation from fire to point of hire.
32. Complete time slip as shown on samples in timekeeper's kits; deduct commissary and property charges.
33. Show in upper right hand corner point to which transportation is allowed. If none is due, enter "none." Do not leave the space blank.
34. Scratch two of the words "laid off," "quit" or "discharged," leaving proper one to indicate action. Show date for which last payment approved.
35. Make certain payee understands every item on this time slip.
36. Have time slips signed by himself and the payee and approved by a forest officer when the payee is leaving job. (Approval by forest officer preferred in all cases possible, otherwise by ranking authority available.)
37. If error is made in the time slip, make a new one. Do not alter or erase.
38. Give the employee the original.
39. Mail the duplicate to the supervisor's office at first opportunity.
40. Complete time slips of transferred employee to the hour when employee leaves camp and sign it. Indicate in space provided at top of time slip the place and time of transfer. Indicate camp or crew to which transferred.
41. Take up time slips of men received by such transfer and make new time slips starting from the hour of transfer.
42. Give employee both originals of time slips when he leaves camp.

CREW FOREMAN

Responsibility and Authority:

Executes the orders of the sector boss and directs the work of one crew. Reports to the sector boss or directly to the fire boss on smaller fires.

Job:

1. Understand thoroughly the work the sector boss wants to have done and how to do it.
2. Plan daily in advance and lay out the work for his crew.
3. See that strawbosses understand what is to be done and the methods to be used.
4. Delegate authority to strawbosses as necessary.
5. Personally direct the work of the crew assigned to him.
6. Remains on line assigned to his crew and works with them at all times.
7. Assigns definite jobs to each strawboss as required to get planned job done, and sees that they do these properly; trains them as need arises.
8. See that efforts are not wasted on unnecessary work.
9. Provides for specially dangerous conditions, such as spot fires, flare-ups, etc.
10. See that strawbosses do not tolerate "gab-fests" and loafing.
11. Keep men distributed along the line as instructed by the sector boss or as conditions necessitate.
12. Obtains information from scout and sector boss regarding work ahead. Scouts as little as possible himself; his job is to be with crew and obtain maximum output on line.
13. Ties in work of crews with that of adjacent crews.
14. Observe and enforce any smoking rules.
15. Teach men to use and care for tools properly and keep track of extra tools.
16. Have a list of his men and check with timekeeper to see that time has been correctly kept.
17. Inspects members of crew for clothing, shoes, etc., and if unsatisfactory, reports condition to sector boss.
18. Make written note of any change of assignment of a man involving change in wage rate and advise the timekeeper.
19. Learns definitely what transportation is provided for the crew.
20. Report to timekeeper regarding stragglers and men left on fire to patrol.
21. See that men have lunches and that water bucks keep them supplied with water.
22. Discharge misfits, loafers and agitators or other unsatisfactory men.
23. Report any discharged men to sector boss.
24. Keep sector boss informed as to additional needs for men and equipment.
25. Have all tools taken to camp at night and placed in a rack marked with crew number and foreman's name.
26. See that dull tools are sharpened or replaced with sharp tools.
27. Report accidents and names of witnesses to the camp boss.
28. See that any injured men get immediate first aid and are properly cared for.

29. Know where each strawboss sleeps, and have strawbosses know where each of their men sleeps. Bed strawboss or foremen crews as units if possible.
30. Be responsible for calling out men on time in the morning.
31. Take crew as unit through wash-up and feed lines.
32. See that crew are breakfasted and are on the line at the hour set by the sector boss.
33. Have men roll their beds and stack them at marked spot when they get up in the mornings.
34. Keep men from milling around in camp. Enforce camp rules insofar as his crew is concerned.
35. Pace off constructed fire line each shift and record in notebook.
36. Keep data in notebook to report to the sector boss on the day's accomplishments.
37. Sit in with other foremen and the sector boss at night when so requested, take part in planning, and make a notebook record of the plan and instructions pertaining to his part of the work for the following day.
38. Be familiar with the best tactics and technique in firefighting as shown in this Handbook and see that they are practiced on the line.

STRAWBOSS

Responsibility and Authority:

The strawboss may be placed in charge of a small crew (10 men or less), portion of a crew, section of line, mopping-up or any other definitely described part of a fire control operation. He is ordinarily under direct supervision of the foreman.

Jobs:

1. Understand exactly what the foreman wants to have done, and where and how it is to be done. Must know the techniques of line building and mop-up set forth in Section 2 of this book.
2. Personally direct the work of the men assigned to him.
3. See that no effort is wasted on unnecessary work.
4. See that men do a reasonable day's work.
5. Keep his men well equipped with proper tools.
6. Show men how to use and care for tools.
7. See that men return tools to designated place at end of shift.
8. See that men keep track of tools and account for lost tools.
9. Help get men out for breakfast.
10. See that men roll and stack their beds before breakfast if required by camp boss.
11. Sleeps with crew at night.
12. Make suitable lunch and water arrangements.
13. Allow no "gab-fests" or bunching up of men.
14. See that his men check out and in with timekeeper.
15. Keep a list of his men and check their time.
16. Look after the safety of his men on the line. Know and apply the safety rules.
17. Care for injured men and report injuries promptly to superior officers.

18. Report presence of agitators to superior officer.
19. Recommend dismissal of lazy or incompetent men.
20. Observe and enforce any smoking rules in effect.
21. Put stop to smoking while riding in trucks or cars in forest.

THINGS TO DO ON ALL LARGE FIRES

Planning:

Appraise probable fire behavior with due regard to all factors and, after considering the size of the job, the facilities that are available and the probable rate of line output, with a reasonable allowance for under-run, develop a plan adequate to control each fire within the first burning period.

Scouting:

Scout enough to know in detail the location and condition of all of the fire at all times, as well as the topographic and fuel conditions of all of the adjacent country into which the fire threatens to spread. Use airplanes for scouting in rough or inaccessible country if necessary. Airplane photography should be used whenever necessary to expedite scouting.

Overhead:

See to it that sufficient qualified overhead is on hand by the time it is needed to fill all of the supervisory and staff jobs. See that there is balanced overhead. Use in previously organized units if possible. Do not break up organized overhead units unless absolutely necessary.

Conserve the energy of all overhead men by providing rest periods at regular intervals, preferably not over 14 hours apart, except during initial runs, when longer hours must frequently be put in to round up the fire.

Supply saddle stock promptly wherever it can be used to save the strength of all overhead above the grade of crew foreman.

Utilize overhead on jobs for which they are qualified. Do not assign them to work above their abilities nor to that unsuited for them. No man should be held responsible for any job which is beyond the scope of his training or experience.

Make suitable arrangements in fire camps to expedite and facilitate the work of the fire boss and other staff men. Reasonable privacy and comfort for staff meetings and discussion of plans must be provided.

Man-Power:

Conserve the man-power resource by:

Using only selected, properly equipped and physically fit individuals with a knowledge of the work to be done and of the country wherever possible. Do not take unfit or poorly equipped men onto the lines.

Working reasonable length of shifts, with regular rest periods.

Getting full production from men when they are working.

Providing adequate number of men for work at hand.

Giving good food. Creating quiet, comfortable conditions for rest.

Supplying water regularly to all crews.

Following best safety practices and assigning best qualified men to handle all jobs, particularly the more dangerous ones.

Treating injuries promptly with first aid and following up where needed with medical attention.

Insuring in advance safe ways of departure for all crews from places of danger.

Locating camps to make trips of men to and from lines as easy on men as is possible. Use airplanes to deliver camp close to job if necessary. See instructions for "Air Deliveries," Section 4.

Transporting men as near to lines as possible in trucks.

Supplying best available tools in good condition and suitable for the jobs to be done.

Seeing that food, supplies, tools and equipment are delivered to the fire without delay, so that labor may be put to work immediately upon arrival if this is the planned use of the labor.

Releasing men promptly when need for them is over.

Production:

Provide sufficient competent supervision to get as high accomplishment on all jobs as can possibly be expected, with due regard to the conditions met and the skill of the crews.

Correlate all phases of suppression between sectors, divisions or with other agencies, if other agencies engaged.

Train men on the fire to perform in the proper manner the jobs assigned, whether it is handling tools or equipment or a supervisory job.

Utilize fully all existing barriers to reduce the size of the job.

Use machinery wherever possible to expedite or facilitate the completion of all work.

Use no more men than are needed to do the work at hand within safe limits of time and with full consideration to the fatigue factor. Send men to camp as they complete jobs and are not needed elsewhere, or if they work themselves out.

Do no more work than is really needed to handle the existing situations and provide a reasonable margin of safety.

Get the men onto the lines by daylight and before dark. Start feeding crews early enough to make this possible, with travel time given ample consideration.

Relieve men before dark, when possible, to facilitate their return to camp.

Supply the best available lights for night work in sufficient number to permit all crews to work to best possible advantage.

Supply specialized tools for special jobs, such as backfiring.

Keep record of accomplishment in line production by fuel types.

Camps:

Develop smooth-running and efficient camps, with the minimum of effort and man-power consistent with needs of jobs.

Costs:

Eliminate wastage of all kinds. Particular attention to quick demobilization, avoidance or reduction of excess supplies, etc. Hold walking time, camp to fire to the minimum.

See that essential records, such as timekeeping, truck and horse hire hours and commissary charges, are kept completely and accurately.

Check all supplies, tools and equipment in and out of camp and in and off lines. Require strict property accountability all along the line.

Keep no more men out on night patrol than are needed to prevent loss of line. A few active men, effectively supervised and working to reduce hot spots, are worth much more than large crews sitting around warming themselves and doing little but drawing pay.

Maps:

Secure and use freely in the field the best available maps. Keep the camp progress map up-to-date.

Written Orders:

Use notes very freely to avoid possible misunderstandings and to record matters of historic value.

Radio:

Get radio equipment onto all large fires in the early stages and use it on the line and in camp.

Weather Forecasts:

Try to get local forecasts wherever possible, but if these are not available, use other local observations as indicators, particularly immediate observations on relative humidity and wind behavior on fires.

FOREMANSHIP

Foremanship plays a more important part in fire suppression than in any other activity. By foremanship is implied the art of obtaining results from the efforts of others. In fire suppression these results must be obtained surely and without delay. Often, time is inadequate for retracting or correcting errors. More often an error means disaster. Therefore, foremanship must be aggressive, positive and complete. Foremanship includes the instruction, supervision, training and leading of subordinates of any rank from fire boss to strawboss. The following principles should be adhered to:

1. Know well what your superior officer wants done and where, when and how.
2. Survey and analyze the job and facilities for doing it. Make a plan of action for each part of phase of the job.
3. Measure subordinates; fit the assignment to the qualifications of the man and not the man to the assignment.
4. Make no man responsible for a job beyond the scope of his training or known qualifications.
5. Instruct in clear, concise language. Check to make sure subordinates understand what, where, when and how. If time permits add the whys.
6. Make definite assignments. Eliminate all necessity for subordinates to guess.
7. Train or coach each subordinate with full production as the objective.
8. Measure output. Require maximum production without undue or unreasonable demands.
9. Respect the lines of organizational authority. Delegate responsibility and authority each in proportion to the other, and do not usurp authority of supe-

riors, nor undercut subordinate officers except when absolutely necessary. Then immediately inform them.

10. Maintain discipline without being officious. Be fair, be strict, be human, be a leader more than a driver.
11. Build morale and confidence through maintaining a steadfastness of purpose and loyalty to the job and the personnel.

FIRE CAMPS

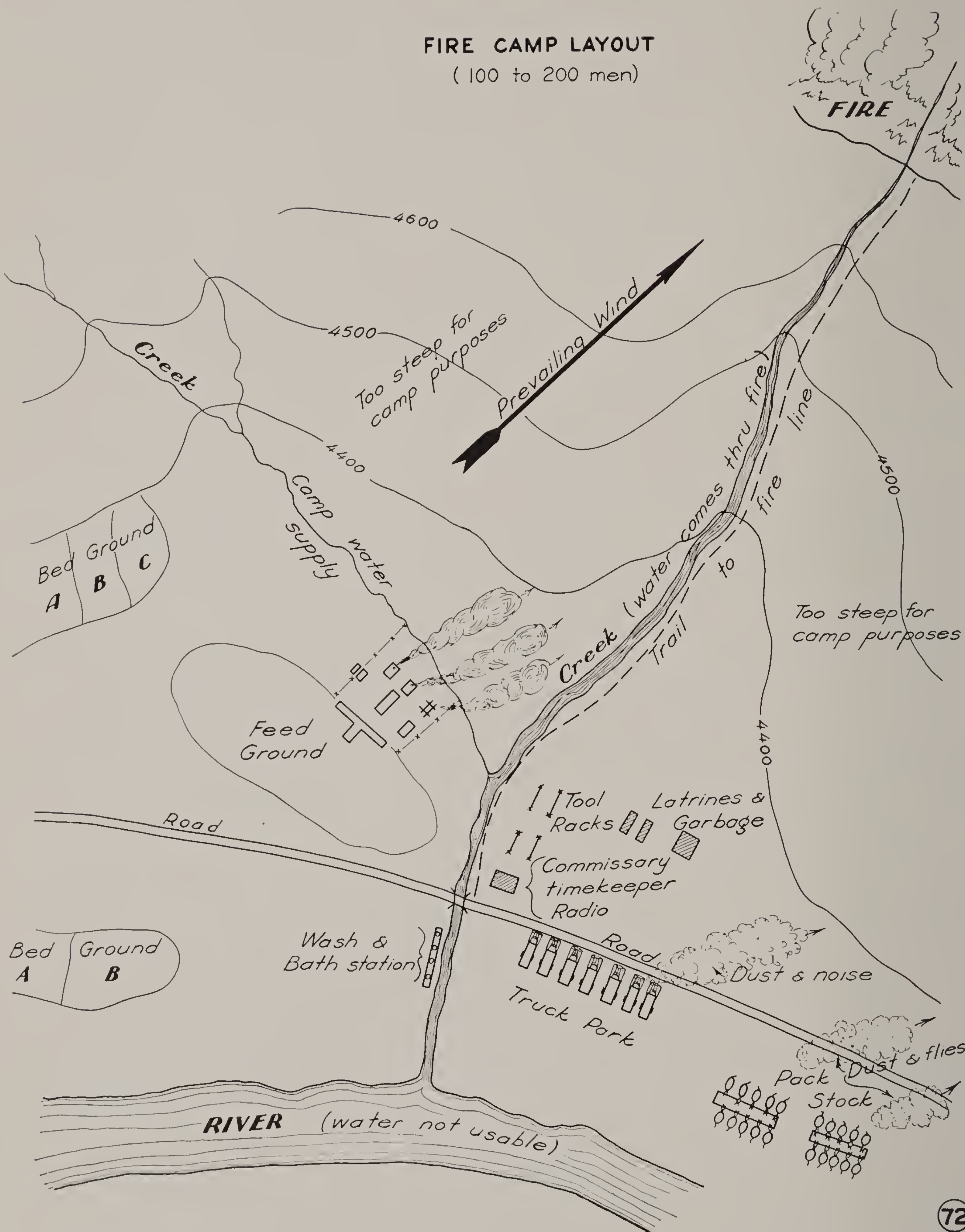
The management of a fire camp is an important job. Efficiency of crews on the fire line is largely dependent upon operation of the camp. A few simple rules, if followed, will facilitate and simplify camp management. They are:

1. Know the job of the camp boss and camp personnel as set forth in Section 3 of this book.
2. Make a plan for development of each camp as dictated by the peculiarities of the site to be used. Don't permit the camp to "just grow up" anywhere that packers or truckdrivers unload the equipment.
3. Remember that time wasted by crews in camp is time lost on the line. Arrange facilities which will reduce to the minimum time used in feeding, tooling up, time checking and get-away. Enforce rules to get it done.
4. Keep in mind that the morale of the entire crew is largely shaped in camp. Make camp operation snappy, fast and easy. Provide for comfort, safety and convenience. This is the only pay the firefighter receives for the hours he spends in camp. Don't cheat him!
5. Avoid extravagant tendencies. Make camp efficient, but avoid frills and unnecessary polish.

PLANNING THE CAMP

The time available for planning a camp is usually very limited. Therefore, a systematic scheme for quick planning is necessary. The following tickler list will assist in hurriedly formulating a plan. (See charts following this topic.)

1. Roughly sketch site, indicating useable ground.
   (a) General wind direction. Smoke, dust, noise.
   (b) Water supply, kitchen.
   (c) Roads, trails. Into camp—to fire line.
2. Locate on sketch and ground.
   (a) *Kitchen.* On windward side. To avoid dust, stench, etc. Put above other camp units on running water.
   (b) *Tool and timekeeper station.* At point where crews will leave and enter camp.
   (c) *Parking space.* Trucks, pack strings where dust, noise and stench will not reach camp.
   (d) *Radio or telephone.* At timekeeper's station if he handles. Away from camp noise if special operator.
   (e) *Bed ground.* In crew units. Reserve ample space. Avoid dusty, noisy location. No snags.
   (f) *Latrines.* Down wind. Accessible to bed grounds.
   (g) *Garbage pit.* Down wind. Away from water.


FIRE CAMP LAYOUT
(100 to 200 men)
FIRE
4600
4500
4400
Creek
Too steep for camp purposes
Prevailing Wind
Camp water supply
Bed Ground A B C
Creek (water comes thru fire)
Trail to fire line
Too steep for camp purposes
Feed Ground
Road
Tool Racks
Latrines & Garbage
Commissary timekeeper Radio
Wash & Bath station
Bed Ground A B
Road
Dust & noise
Truck Park
Dust & flies
Pack Stock
RIVER (water not usable)
72

Existing circumstances will determine procedure. If line crews arrive simultaneously with camp boss and equipment, the first job is to tool up and get crews started to fire. Unload only the supplies needed for them to take to line. Hold mess outfits and food on trucks until kitchen site is definitely located.

Kitchen:

Stoves and open fire so smoke blows away from kitchen. Wood for Kimmel stoves 20 inches long.

"T" table for double line feeding. See chart. 16 to 20 feet long, depending on size of crew. Not over 30 inches high. For table, get:

10 posts, 4-inch top; 1½ axe handles long.
6 crossarms, 3-inch top; 1½ axe handles long.
2 top poles, 3-inch top; 3 axe handles long.
2 top poles, 3-inch top; 7 axe handles long, or
4 top poles, 3-inch top; 4 axe handles long.

Cook's work table:

6 posts, 4-inch top; 1½ axe handles long.
3 crossarms, 3-inch top; 1½ axe handles long.
2 top poles, 3-inch top; 4 axe handles long.

Tent fly (if used):

4 poles, 3-inch top; 6 or 7 axe handles long.
1 pole, 3-inch top; 5½ axe handles long.

Supplies:

Food stacked on poles on ground.
None stored under serving tables; they leak.

Rope or pole fence:

Keep loafers out of kitchen.

Garbage:

Dry pits, down wind. Don't burn. Wind changes and stench bad. Boxes at kitchen for dirty dishes and table scraps. Put on down wind side; flies.

Latrines:

Down wind. Screened from camp, road and trail. Pole 4 inches in diameter; dead wood best. No pitch. Set not over 20 inches high (2/3 axe handle). Directional signs—blazes from camp and bed grounds.

Parking Lot:

Down wind. Trucks and cars headed out. Drivers stationed.

Bed Grounds:

Windward side. Quiet; no smoke or dust. Crew units; location of foremen. Away from kitchen water supply. Snags are dangerous; cut for wood. Warm-up fires for each bed ground. Signs—directional—crew assigned.

Wash-up Station:

Down stream from kitchen. Well drained ground; no mud. Lantern night and morning. Towel racks in sun for drying. Signs—directional from timekeeper's station and bed grounds.

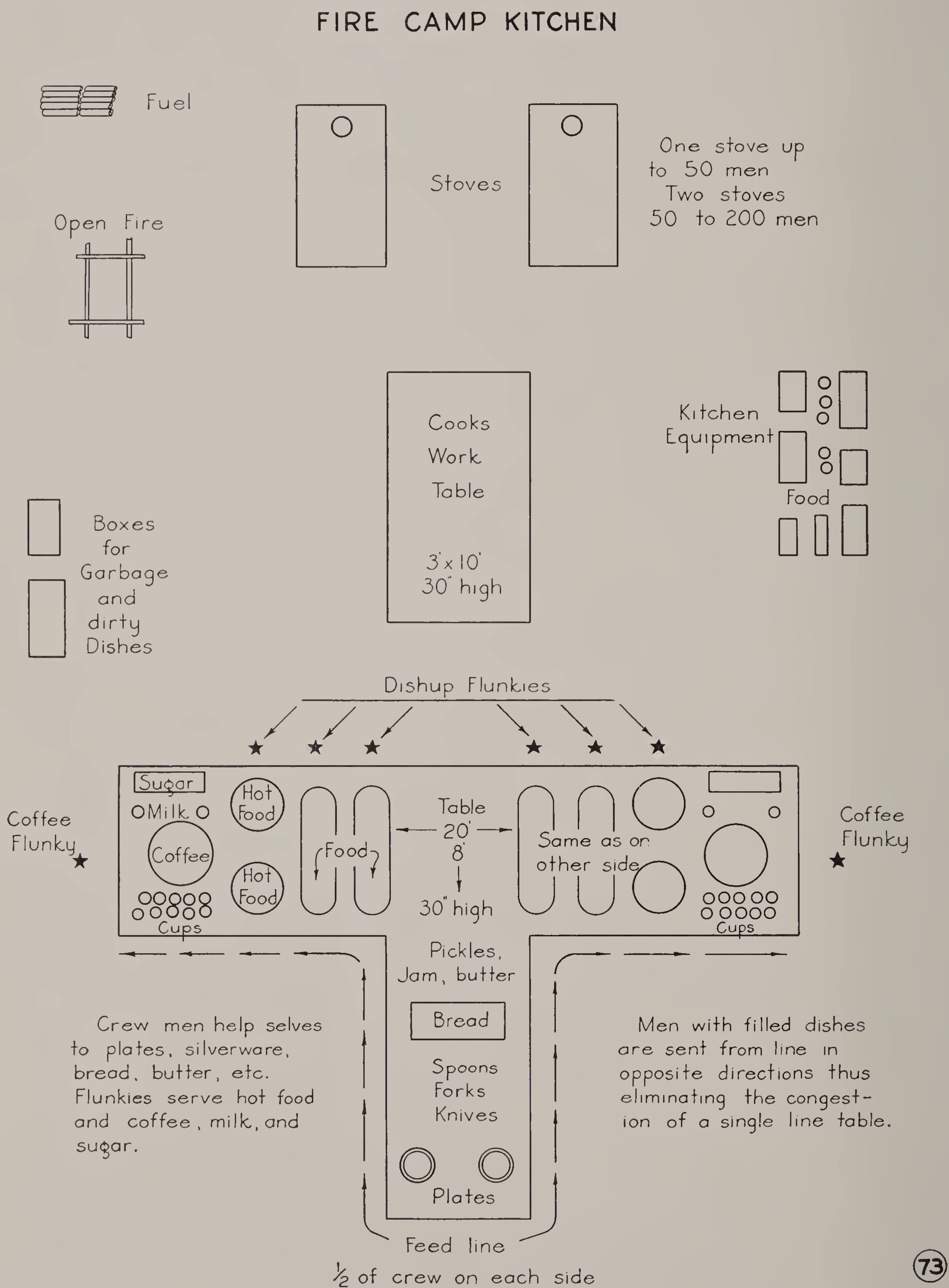
Timekeeper's Station:

Proper location to see men come in and leave camp, tool supplies, etc. Accessible

as commissary. Fence to keep out loafers. Tool racks; one for each crew. Racks simple: single pole 2½ feet above ground. Fasten to posts, trees or stumps. Lean tools against pole—safer, adequate. Signs; name or number of crew.

Stable:

Packstock. Down wind; stench, flies. Downstream from camp water supply. Snags dangerous. Rocks; logs with sharp limbs or knots. Space at hitch or feed racks, 6 feet per animal.



METHODS OF LINE ORGANIZATION

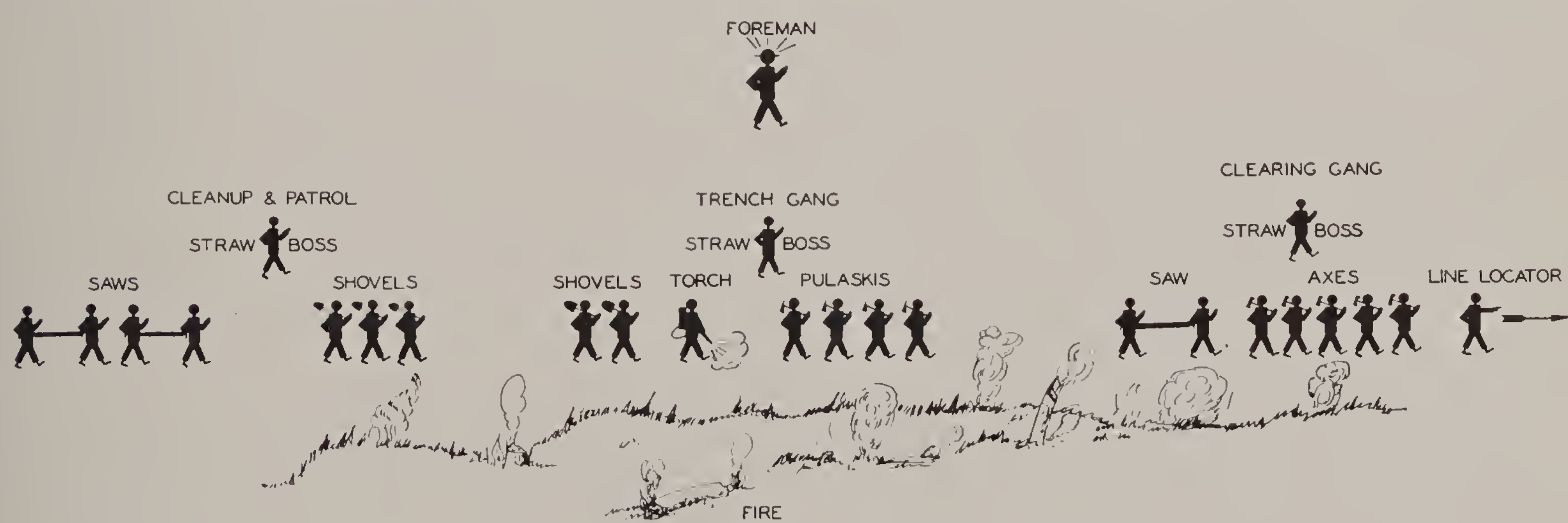
After the many steps of management preparatory to actual attack are completed, and men reach the fire, decision must be made as to what form or method of line organization will be used. This is one of the most important matters facing the fire boss.

Perhaps the calculation of probabilities, dispatching, mobilization and determination of strategy have all been carried out to a high degree of precision, yet all will be of no avail should he use an improper method in organizing and managing his line work.

By line organization method is meant the arrangement and management of men and functions within each work unit. The methods described in this chapter have been perfected by years of cut and try experience. Each method has its definite place in Region One firefighting, and every man responsible for directing a crew or crews must be familiar with all these methods before fully qualifying as fire foreman. It must be clearly understood that, while each method is recognized as best under certain conditions and circumstances, no one method is satisfactory for all situations. Each line construction job must be sized up and the method applied which offers the greatest results in terms of chains of held line per man-hour. Likewise, on one sector, conditions may vary to the extent that two or several methods of line organization are necessary to obtain maximum results. This means that the manager must never be a "one method man." He must know them all and use each as circumstances require.

FUNCTIONAL CREW UNIT ORGANIZATION

The most common method, and perhaps the one used too often in this Region, is the old crew unit scheme, by which each crew has but one function to perform. The functional unit organization is that method where, the first crew over the line, carries axes or pulaskis and clears line of smaller fuels sufficient to permit trench construction. The next crew is the digging crew, using pulaskis or hoes and building trench. The next unit will be the clean-up crew, burning out lines with torches. Next come the saw crews felling snags and cutting punky logs from across the line.



FUNCTIONAL CREW UNIT ORGANIZATION
25 MAN CREW
RATIO OF MEN BETWEEN UNITS TO BE ADJUSTED TO MEET CONDITIONS

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The patrol and mop-up crews then take over the line. Best use of this system is where resistance to control is extremely difficult, and where there is sufficient work of each particular kind to permit functionalizing each unit without loss of time or energy in moving men from completed jobs to new ones.

Advantages of This Method:

1. Each member of functional crew unit is under constant supervision of a strawboss or foreman.
2. It permits assigning worker to the tool with which he is most skilled.
3. Reduces amount of tools needed, since each man has but one.
4. Makes an entire organized crew unit available for action on hot spots or break-overs.
5. Promotes competition between units in that each tries to keep ahead of the others.

Disadvantages:

1. Men are bunched up and usually lose much time crawling around those ahead each time one moves up to new work.
2. Greater chance for accidents with men working close together.
3. Constant shifting of men from one functional squad to another as fuel types change. Axes idle or get too far ahead when open ground reached, or may get behind and hold up entire crew when a short section of heavy clearing is encountered.
4. Gang work; not possible to measure output of the individual.
5. Lacks flexibility necessary to permit pulling out crews for spot fires, etc. Entire unit must be reorganized each time.
6. Considerable chance for clearing crews to get too far ahead of trenchers and burners; fire may cross between units.

THE INDIVIDUAL ASSIGNMENT ORGANIZATION

This system of organization is developed for use in lighter type fuels, or on slow-spreading fires. The underlying principle is the assignment of a specific, marked piece of line for each man in the crew to build, except that men will be selected as saw crews the same as in the squad method, and for special jobs such as spot fires and hot spotting ahead of line construction. Before the men are distributed along the line, they are assembled at the point where their work is to begin, instructed in their part and responsibility, and given a pattern of the type of line work to be done. Each man is equipped with a shovel for cooling down the fire with dirt and scraping in the edge, and a pulaski for trimming out brush and limbs, chopping small poles and digging trench where needed.

The distribution is made by having the strawboss lead the crew slowly out along the edge of the fire, the men being instructed to do no work until assigned by the foreman who drops them off from the rear of the line on marked sections. These sections will be equalized as to the quantity of work as nearly as the foreman can judge and of an average length decided upon beforehand to best suit the conditions in each case. This places individual responsibility on each man, shows up the loafers or misfits, prevents men passing or interfering with each other and stimulates effort and pride of accomplishment.

The time of the foreman and the strawbosses is devoted to teaching and directing the men individually as they move back and forth, the strawbosses among their own squads and the foreman working through the strawbosses with the entire crew.

As the work of line construction nears completion on the individual sections, some will finish before others. The foreman then has his choice of making adjustments by having the men who finish first help their neighbors or by having them go ahead on their own sections with essential mop-up jobs. The latter is generally preferable but the decision will be governed by the urgency of getting ahead and in either case there is no lost time.

The move ahead of a new section of line, in case the entire perimeter of the fire is not manned from the start, is made by picking up the entire crew progressively from the rear of the completed section, no man being allowed to pass another on the line. When the head of the completed line is reached, the men are in line for redistributing to the new section in exactly the same way as was done in the first place. In nearly all instances it is desirable to organize mop-up work immediately behind line construction. For this work men are selected and assigned their beats before the crew is moved forward and a mop-up strawboss remains behind to supervise the work.

While this method of individual responsibility is especially suited to the *direct method* of attack, it is entirely practicable to the building of line under either of the other methods.

Advantages:

1. Permits simultaneous attack on larger porton of fire's edge than any other known method.
2. Definitely places responsibility on each individual for output.
3. Eliminates much loss of time and confusion in moving men forward to new work.
4. Decreases much chance for injury by spacing men.
5. Incites interest in work in that each man's output is visible.

Disadvantages:

1. Requires individual training of each crew member in all phases of line construction and holding.
2. Most members of crew are out of sight of strawboss greater part of time.
3. Necessitates providing two tools for each man.
4. Does not provide a connected line from beginning of operation and, therefore, does not provide avenue of escape as safety factor.
5. Scatters man-power to extent that temporary concentration of forces to strike a hot spot is difficult.

PROGRESSIVE STEP-UP ORGANIZATION

This system differs from the ordinary functional crew unit scheme in that the entire crew progresses forward with each member occupying the same position through the work period. The entire crew moves forward, each member maintaining a constant position in relation to the other workers.

The principle is that each member of a unit has a definite assignment of work to accomplish, and will work on this section until it is completed, or until some other member of the unit finishes, then the whole crew moves forward to new ground. The number of step-ups to be moved forward is the same as the number finished.

Ordinarily the following routine is followed:

The crew consists of three 7-man squads with a strawboss in charge of each.

These three squads are exclusive of one or more saw crews which are stationed at the rear of the unit. The first squad, which follows the line locator, is composed of axemen whose sole duty is to clear the way for digging tools. Following the axemen is the grub hoe squad, whose duty it is to loosen the ground for the third squad of shovel men who shovel out down to mineral soil, leaving behind them a finished trench. Large logs and snags left by the axe crew are cut by the sawers. Each saw crew is composed of three men, one of whom has a shovel to dig out under logs and to complete trench after sawing.

To add flexibility to this foreman's unit, the last two or three men in the axe squad are equipped with pulaskis instead of axes. Then, if the clearing work becomes heavy, the pulaski men of the hoe squad can assist the axes or, if the digging is slow and difficult, the pulaski men of the axe squad assist the hazel hoes.

The men progress with their line construction as follows:

Each squad, *before they start work building line,* space themselves a given distance apart (about 15 feet) along the ground where the line has been located. Individuals are assigned to a definite position within the squad, numbered 1, 2, 3, 4, 5, 6 and 7, and they remain in that relative position at all times. For illustration, assume we are dealing with the axe crew composed of seven choppers and one strawboss in charge. The number 1 or leading man walks out the located line 90 feet and stops. The number 2 man walks out 75 feet, which places him 15 feet behind the leader, and so on with the entire seven men. This leaves the seventh man standing at a point where line construction is to begin. A simple way to obtain the proper spacing is to instruct the squad boss to stand at the point of beginning and have the men file past him in order, 15 feet apart. When the last man is reached, he cries, "Halt!", and the crew is then ready to start work.

It is the duty of each squad strawboss to supervise the work of his crew and as this requires all of his time, he uses no tool except in rare instances.

After the squad is lined out, they all begin work simultaneausly at their strawboss' command. Each man *completes* the work required of whatever tool he is using as he goes. For example, if he is an axeman, he does all the clearing that has to be done as he advances, or if he is a hoe man he completes the soil, loosening as he goes.

Due to variations in working conditions, even from one end of a squad to the other, it is always the case that one or more men reach the point where the man ahead of him started before the others, and thus he has nothing further to do unless he goes past the men ahead. In order to avoid this undesirable procedure, the strawboss, whose duty it is to observe when a man completes his portion of line, makes a loud verbal command such as "four" (pause) "up one," or "Smith" (pause) "up one." This command implies to the squad that Smith, who is number 4 man in the squad, has completed his section of line and that all workers in front of and including Smith must move up to the point where the man ahead was working, while number 1 steps forward 15 feet.

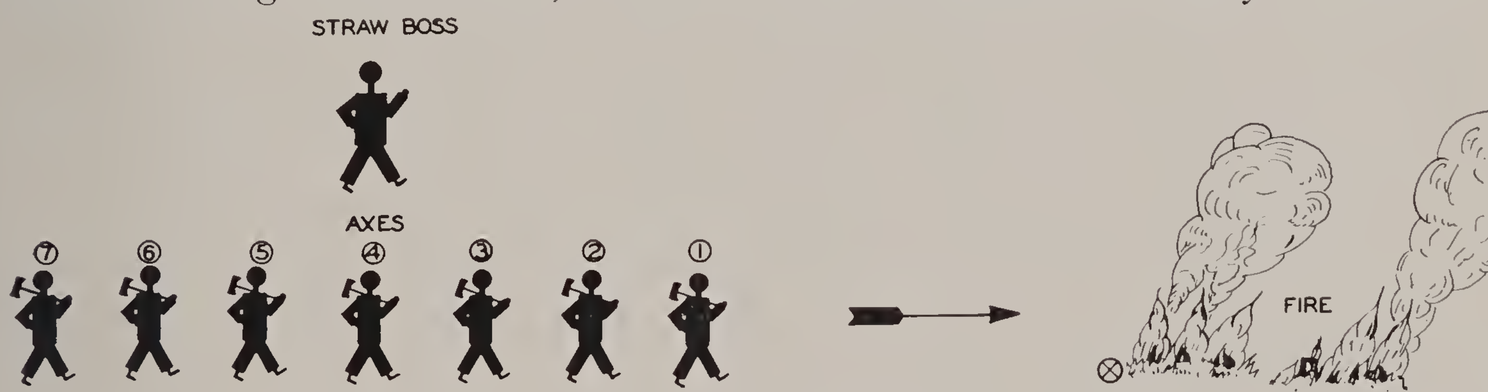
If two men finish at the same time; for example, numbers 4 and 5, the strawboss indicates the name or number of the one *closest to the rear of the squad* (in this case number 5) and orders up *two,* thus: "Five" (pause) "up two." This order implies to the squad that all the workers in front of and including number 5, move up two spaces, while number 1 goes out 30 feet and number 2 out 15 feet beyond the point where number 1 was working prior to the order. The reason only those from the finishing worker forward move up at an order, is that, if the entire squad ad-

vanced there would be no one with that type of tool to complete the space left by the last man after he changed position.

Under this system it is obvious that the strawboss is the key to a smooth working squad, and it is extremely necessary that he be alert at all times. Also, it is essential that the leading or first man in each squad know how to pace or be able to judge distances as it is he who controls the spacing of men. The foregoing description of squad control applies to all squads regardless of tools, except the saw crews which, because of their type of work, together with the fact they are last in the foreman's unit, merely progress as the logs, etc., are removed by them. One set of sawers often requires no strawboss, but when two or more are used the need for a boss to line out the work is evident.

The foreman, in addition to directing the attack and assuming responsibility for his portions of the fire, controls the functioning of his unit through each squad strawboss.

The following diagrams and descriptions portray the functioning of the organization on the ground at a fire, from the moment the men are ready to be lined out.



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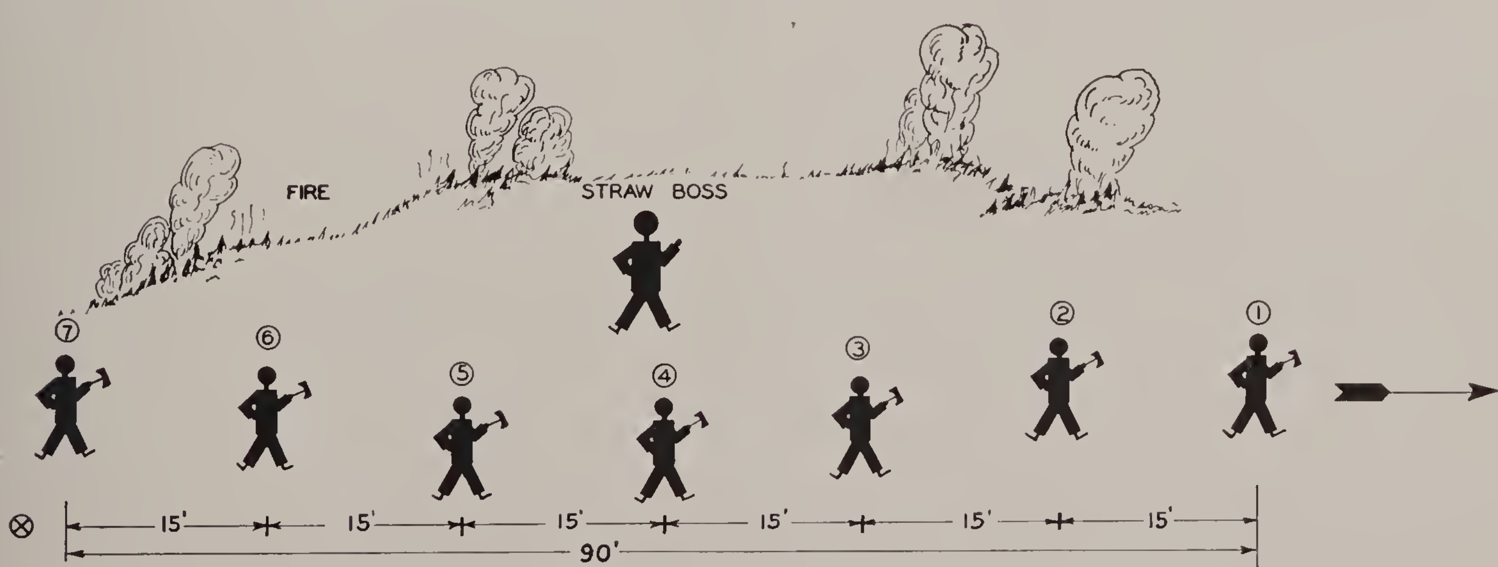
In the above illustration, the point where line construction is to begin is represented by the letter "X." The figures in circles represent the men grouped in close file in their relative positions within any squad at "X." Number 1 is the lead-off man and number 7 is the last tool-equipped man in an 8-man squad. The strawboss is the eighth man of the squad. The arrow indicates the direction in which line is to be built.

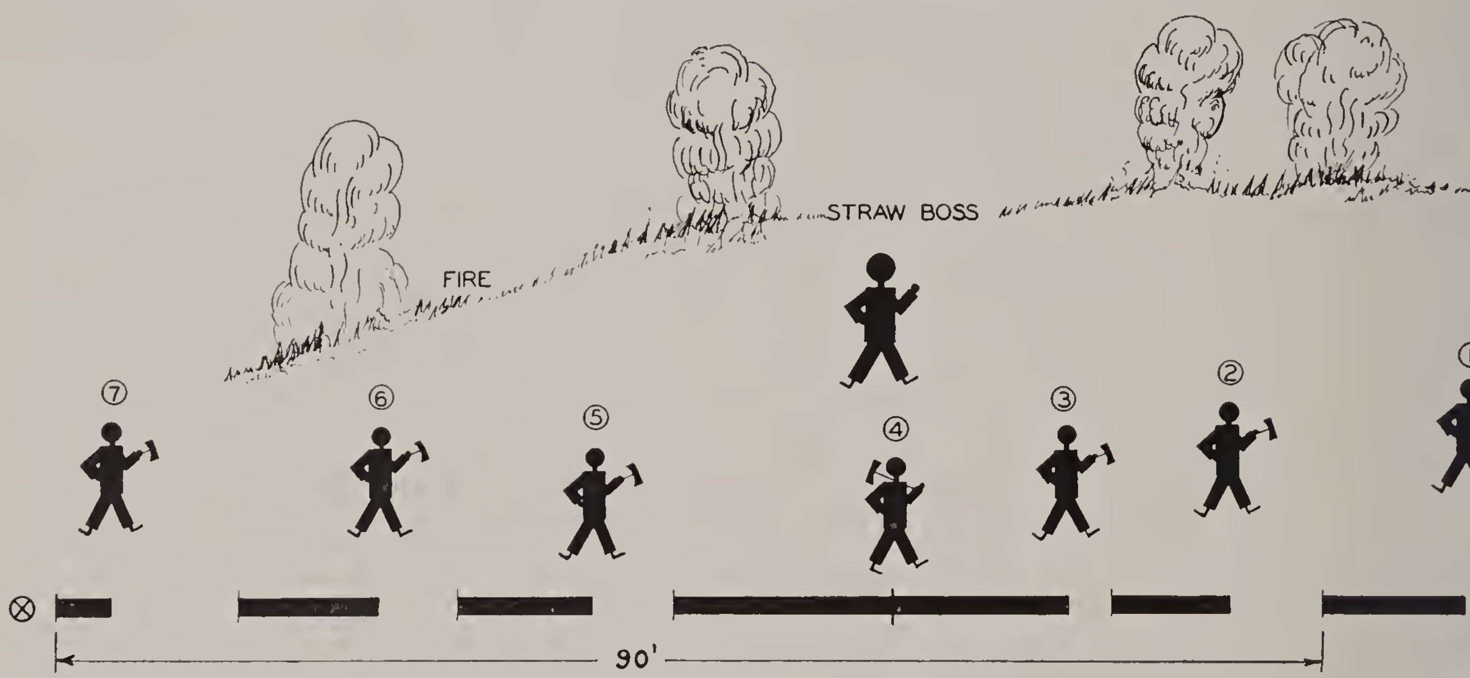
The strawboss allows the men with their tools to file past "X," holding each individual in turn at that point until the man ahead has moved out 15 feet. Number 1 steps out first, followed by 2, then 3 until number 6 is reached. When 6 has advanced 15 feet, the strawboss shouts "Halt!". This leaves number 7 at "X," number 6, fifteen feet out, number 5, thirty feet out and so on to number 1 who is 90 feet from "X." See illustration below.



64

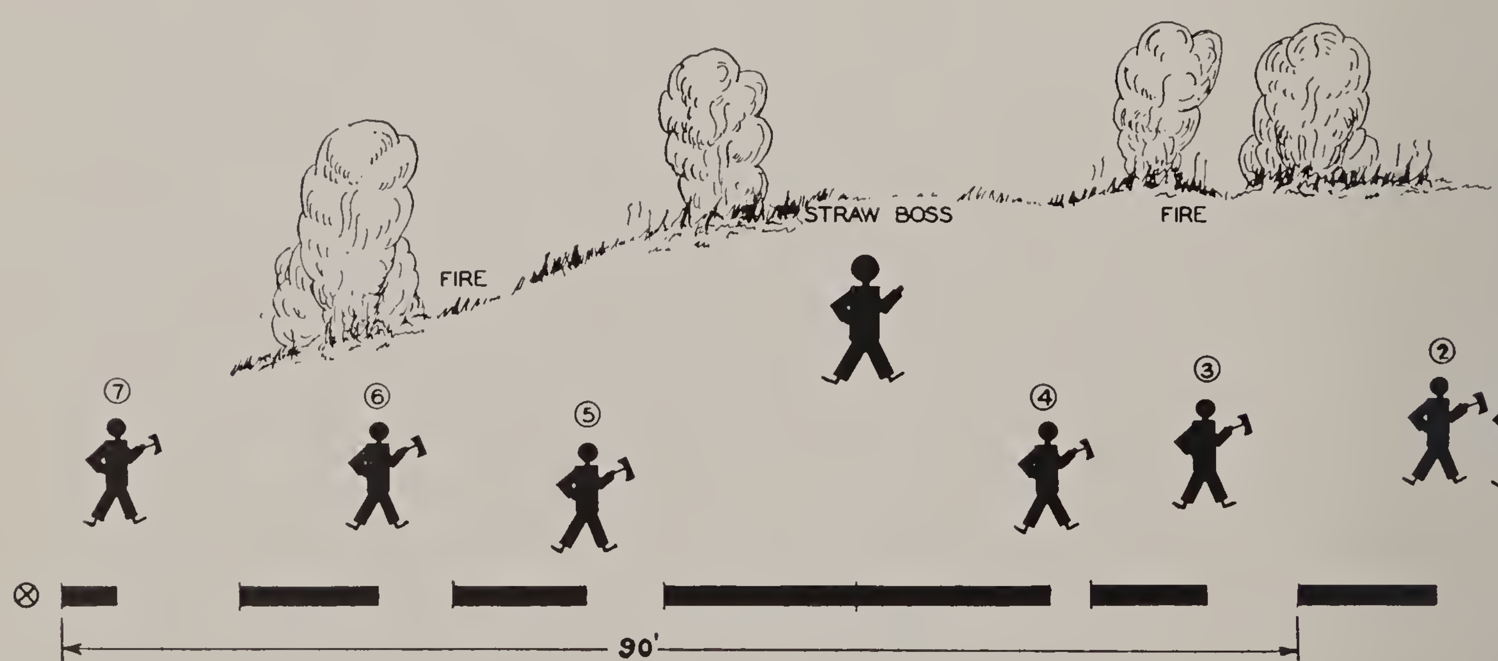
Following the above procedure, the strawboss gives the command to start work. Each man works always toward the man ahead, i.e., 7 towards 6, 6 towards 5, etc. Also, as he advances in this manner, he completes as he goes *all* the work required of whatever tool he is using.

After a short interval of time, some one man within the squad reaches a point where the man preceding him started work. The relative positions of the men, showing work accomplished up to that moment, is illustrated below:



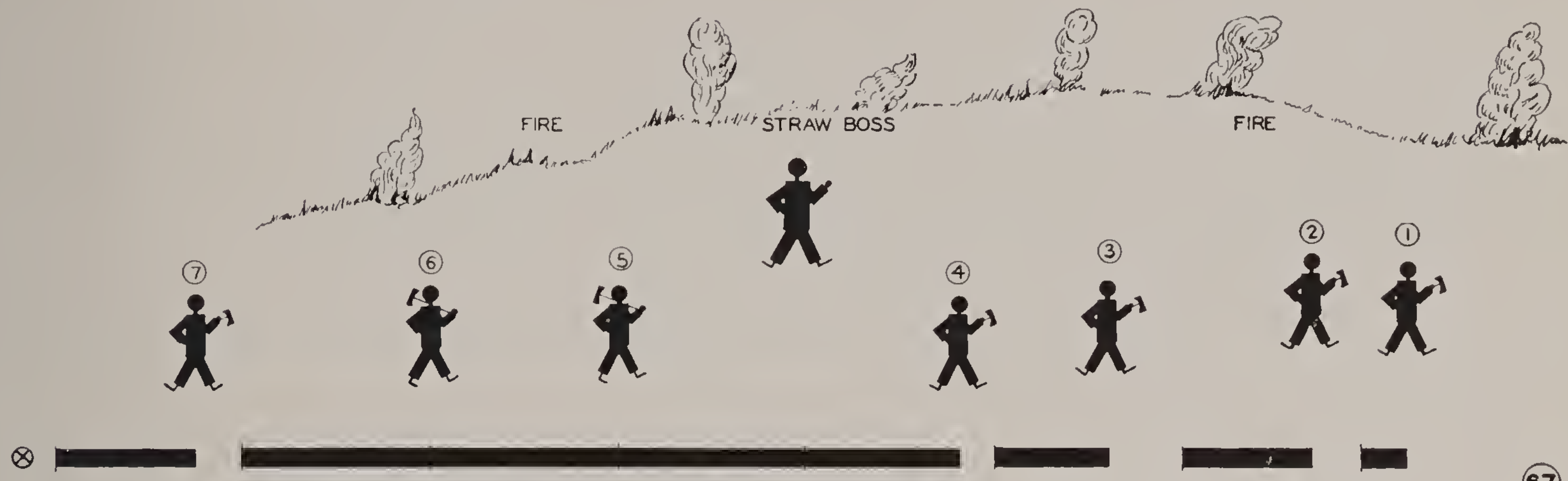
65

The perpendicular line represents where each man started working. The solid line represents work accomplished up to the moment number 4 reached the point where number 3 started. As 4 reaches 3's starting point, the strawboss shouts "four" (pause) "up one," indicating that everyone from 4 through 1 move up to the spot where the man ahead is working. Number 1 moves forward 15 feet. Numbers 5, 6 and 7 do not move but continue working where they are. The result is diagrammed below:



66

As the men continue working let us assume that numbers 5 and 6 reach simultaneously, the point where the men ahead of them started. The positions at that moment are indicated below:



67

The strawboss then orders "Six, up two." Number 1 moves out 30 feet. Number 2 moves out 15 feet beyond the point where 1 was working prior to the order, which places him 15 feet behind the new position of number 1. Number 3 moves into the space behind 2, which is the spot where 1 was working, and so on down to 6. Number 7 does not move up. The new positions are indicated below:

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At any time the order is "up two" or more than two, it is best number 1 be allowed to place himself in his new position first. Then 2 places himself behind 1; 3 behind 2 and so on in order. In this way it is necessary for only the leading man to estimate the distance to his new position as everyone in turn following, places himself in the space immediately behind the man ahead.

It should be understood that whenever number 7 reaches the point where 6 started, the order "Seven, up one" applies to the entire squad and everyone advances one space.

The foregoing descriptions and diagrams of positions are applicable to all squads regardless of tools used except the saw unit. Application of good judgment by the strawboss in issuing orders, and accurate estimation of distances and knowledge of pacing on the part of the number 1 man in each squad, cannot be overemphasized if maximum efficiency is to be gained from this method. Numerous demonstrations by trained CCC crews and calculations of trench constructed per man-hour under all conditions, have proved definitely the "Progressive Step Method" is noticeably superior to many older methods. Not only is speedier work accomplished, but also a finished trench is assured when the last man passes any point, and in addition the output of each individual is evident at all times. There is no opportunity for "soldiering" on the job.

From the standpoint of safety, the method has further advantages. Workers are not passing one another while carrying sharp tools. They are never so close together

there is danger of one striking the other, and, third, in adherence with our safety regulations, each man has opportunity to assume the proper stance while using his tools.

THE AUSTIN ROTARY ORGANIZATION (FOR GRASS FIRES)

This scheme for handling men on the line was developed to speed up suppression of fast-spreading fires in light grass fuels. It is a progressive method and eliminates any lost motion if properly managed. It has proved very effective for small crews on cheat grass fires.

Normally, not more than five men are used. Four is an adequate number where digging is not too difficult. The scheme will not work where mineral soil is not available, since the whole procedure reduces down to "knocking the fire out with dirt."

When the edge of the fire is reached and an anchor spot is found, the procedure is as follows:

Assuming one four-man crew, each equipped with a shovel and canteen of drinking water.

The first man fills his shovel, steps close to fire edge and whips the load of dirt as hard and as far as possible up the fire edge, one-half the dirt striking inside fire and one-half outside. He throws his dirt while moving forward; does not stop but moves ahead parallel to fire about three times the distance his shovel of dirt covered. (Each shovelful, if properly whipped, will knock out fire to 10 feet, depending on density of grass.) He moves one or two steps away from fire and begins loading his shovel again.

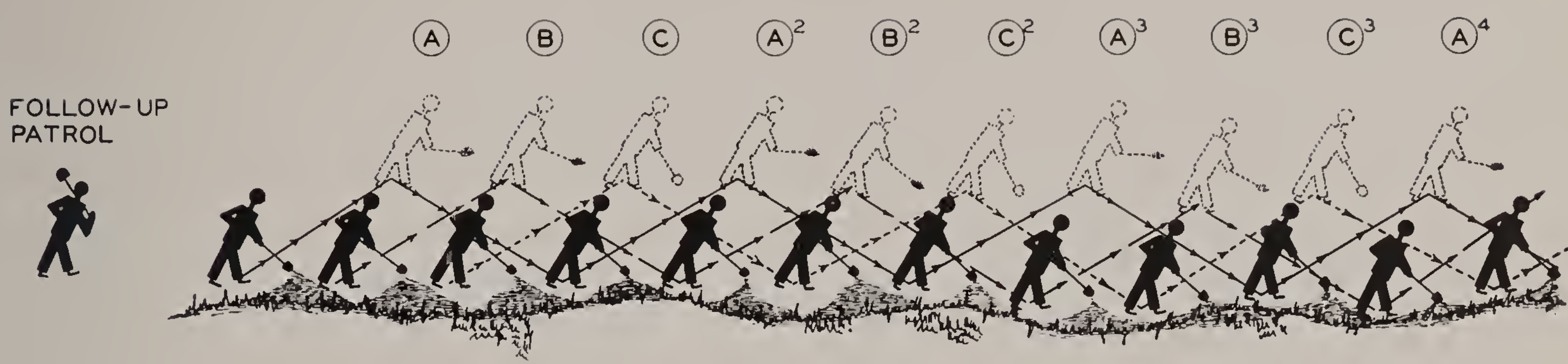
Man number 2 steps to fire edge at point where number 1's dirt swath ended, whips his shovelful and moves quickly ahead to a position beyond man number 1.

Number 3, following number 2, releases his shovelful of dirt and follows the action of number 1 and number 2. They have knocked the fire down to a point opposite number 1, and he immediately begins the procedure all over again. This is repeated time after time, each man maintaining his constant position in the crew.

Number four follows behind at all times, shoveling in smoldering chunks of wood, dung, roots, etc., and extinguishes those persistent tufts of matted grass which were not completely knocked out.

This movement gives the appearance of a three-man wheel roiling up the edge of the fire. Where dirt is plentiful, a four-man crew moves forward about as fast as they would ordinarily walk.

The following sketch better illustrates this method:



AUSTIN ROTARY ORGANIZATION
FOR GRASS FIRES
FOUR MAN CREW

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TORCH AND FLAPPER ORGANIZATION (FOR GRASS FIRES)

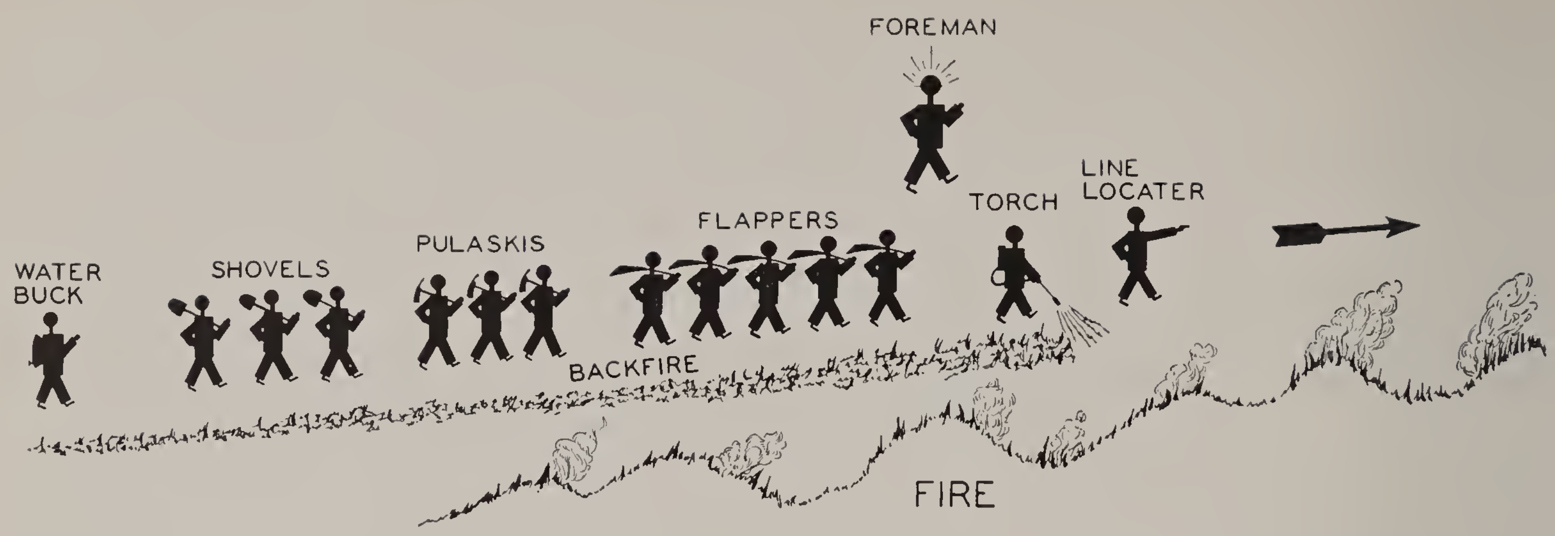
An adaptation of the "One Lick" method to meet the conditions and requirements of grass fire fighting has been successfully worked out by Region Three. This system is progressive in that the entire crew moves forward along the line with each member maintaining a constant place in the lineup.

It has the greatest value on large grass fires where indirect method of attack is used. However, it can be used to excellent advantage in direct or parallel attack. It is perhaps one of the fastest methods of building completed fire line in grass types. It requires a crew of 15 or more men. It is organized and functions as follows:

Assume normal August burning conditions; a fire of sufficient size to justify crew action. Cheat grass on topography varying from level to very steep. A 15-man crew is available. They assemble at starting point or anchor of line.

A line locator moves ahead as far as possible without being lost to sight of first man in crew. Next a torch man moves forward, firing continuous line selected by locator. Five flapper men follow immediately behind torch, knocking out edge of backfire on side away from main fire. Three pulaski men come next, using one lick tactics in cutting off strips of smoldering material left by flappers. Three shovel men fall in line behind the pulaskis and shovel in smoldering fuel, constantly moving forward. Last comes the water buck with a 5-gallon manpack of drinking water, but having a hand pump attached at all times to act on any spot which may flare up outside.

The entire crew moves forward continuously, adjusting speed as indicated by the foreman who maintains a position about mid-way in the crew but off side sufficiently to permit his seeing entire operation.. Two matters of most importance for the foreman to watch are: location of line and to guard against torch getting too far ahead of swatters.



TORCH AND FLAPPER ORGANIZATION
FOR GRASS FIRES
15 MAN CREW
NUMBER OF EACH TYPE OF TOOL DEPENDS UPON FUEL TYPE

70

Advantages of System:

1. Permits use of backfire to straighten and shorten lines.
2. Leaves a safe, connected line behind at all times.
3. Provides assortment of tools adjustable to meet all ordinary variety of problems in grass fires.
4. Keeps whole crew intact and available for concentration on hot spots if necessary.
5. Eliminates all lost motion. Each man does work at every step ahead.

Disadvantages:

1. Danger that backfiring may be swept away from flappers on steep ground, or when flanking around head of fire counter to wind.
2. Flappers become almost useless when fire gets into area of cliffs, rock ground or fuels heavier than grass.

THE ONE LICK ORGANIZATION

This method was devoleped as a means for eliminating moving men through or around lead crews, and to provide a system of line management whereby every man in the crew would be constantly constructing line and moving forward.

This type of organization is used only in line construction. Burning out, backfiring, snagging and mop-up are handled as in other methods.

The one lick construction crew is managed as follows:

Assuming a standard 25-man crew, including one foreman, three strawbosses and twenty-one crew men. (A scout or line locator is added.)

Assignment of functional tools, of course, varies according to the fuel type encountered. For medium-medium fuel in Region One tools would be about as follows:

First strawboss unit:

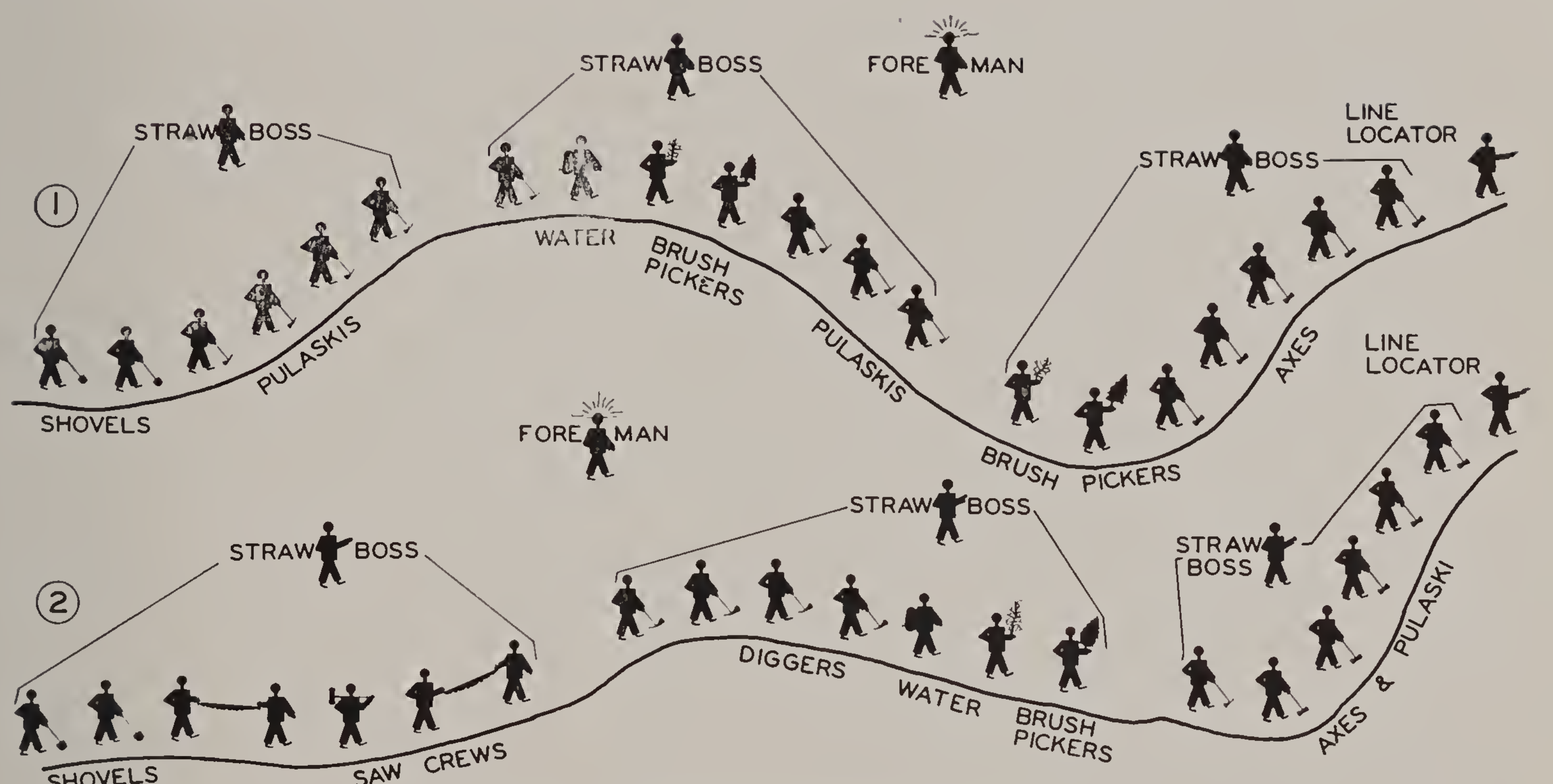
5 axes.
2 pulaskis.

Second strawboss unit:

1 water bag.
4 pulaskis.
2 men without tools (brush throwers).

Third strawboss unit:

2 saws.
1 axe.
2 shovels.



ONE-LICK CREW ORGANIZATION

(1) POSSIBLE DISTRIBUTION OF TOOLS FOR FUEL TYPE WHERE MAJOR JOB IS AXE WORK.

(2) POSSIBLE DISTRIBUTION OF TOOLS FOR FUEL TYPE WHERE MAJOR JOB IS DIGGING AND HEAVY CUTTING.

(71)

The number of tools of various types must be carefully considered by the foreman. He can make possible quick changes in function of crews by placing several pulaskis in the chopping squad instead of using all axes. When chopping becomes light, he can have the pulaski men turn the tool over and assist the diggers. Likewise, when digging is light or when the chopping crew begins to hold up the trenchers, part of the diggers can clear line by using pulaskis as axes. The number of men designated to throw brush and other material out of the right-of-way depends upon the type of fuel. A sufficient number must be provided to remove all debris which is too large to be brushed out by pulaski equipped diggers.

Management on the line is as follows:

The locator works ahead, blazing the line to be followed. He must move fast and must be well schooled in the art of line location.

The axe crew start up the marked route walking forward in single file, constantly striking one well directed blow at each step. Forward speed must be sufficiently slow

to permit each man to maintain balance and accurately aim his blow. Each succeeding man strikes a lick as he passes and so on and on, until the line is cleared of material of axe size.

Next come the brush pickers, throwing out the material cut by the axe men, and other debris readily movable.

The digging crew follows, each man striking a blow or two at each step, making trench where possible with every lick and loosening earth and root mats for the shovels which come along later.

Saw gangs follow, cutting out punky or fast burning logs, leaving sound or wet logs for later treatment by mop-up crews.

The shovel gang comes last, finishing trench built by the pulaski or digging crew.

The entire unit, except for saws, moves ahead after or as each lick is struck. The speed forward is regulated by the foreman. His objective is to leave a completed, connected fire line behind. Each member of the crew maintains one position in the line-up throughout the operation. There is no crowding through or passing around.

Spacing of men must be far enough apart to assume safety from injury by each other's tools and to avoid interference.

Section IV

SECTION IV

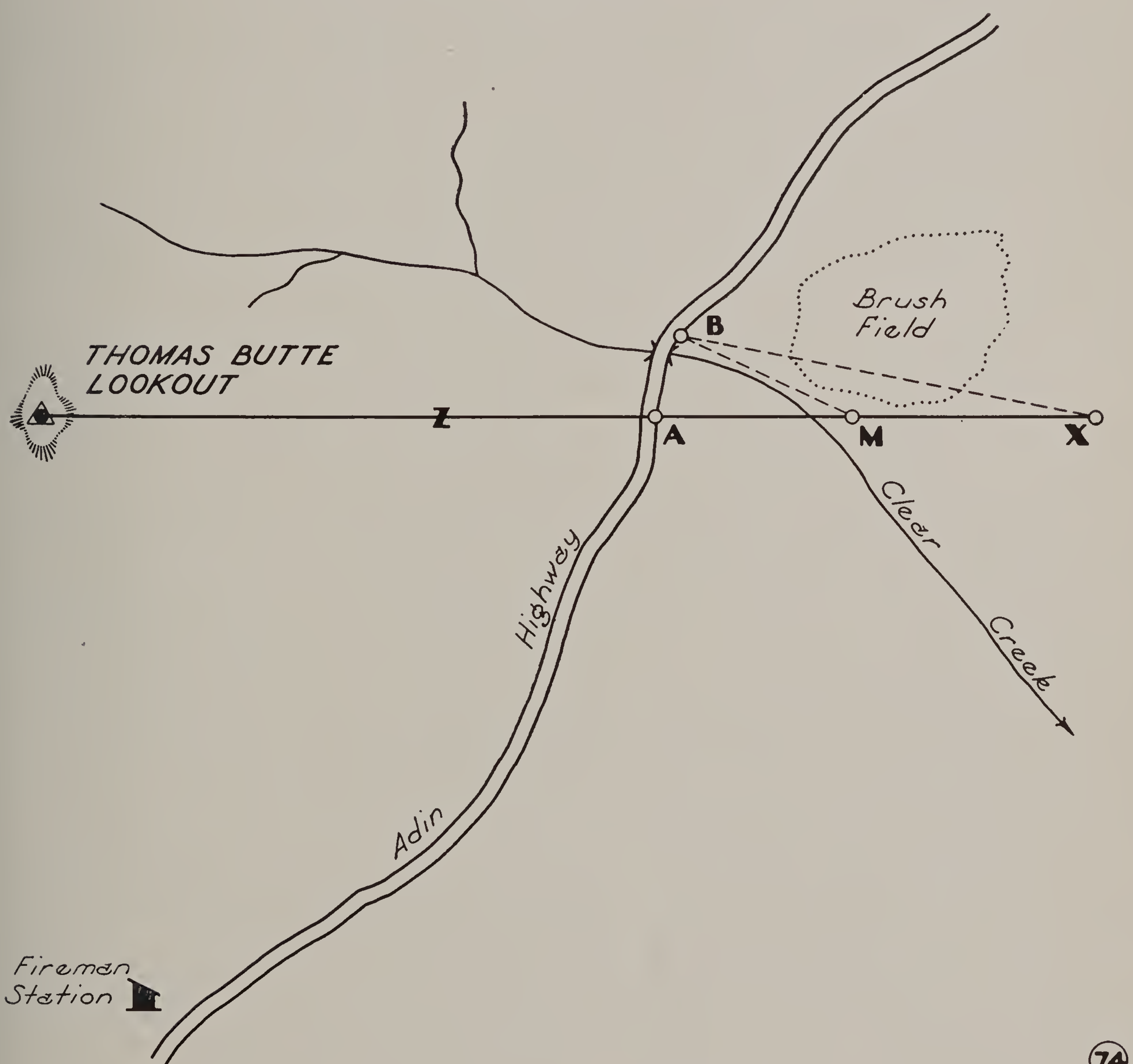
MISCELLANEOUS INSTRUCTIONS

The material comprising this section includes many techniques and instructions which are directly related to topics in previous chapters. Such information is segregated in the form of reference material to avoid repetition.

SPECIAL METHODS USED BY GUARDS

USE OF MAP AND COMPASS IN LOCATING FIRES

PROBLEM 1



Condition:

Fire located at X by Thomas Butte lookout, with cross shot from another lookout. Generally flat country. Little smoke showing and probably will be hard to find fire in heavy green timber. Estimated distance A to X is 128 chains. Fireman equipped with map and compass.

Action Required:

Fireman receives from dispatcher and carries out following instructions:

1. Spots fire on map, draws line on his map from lookout to fire and records azimuth from Thomas Butte and other instructions as given by dispatcher.
2. Proceeds to Clear Creek bridge, thence paces back 20 chains to point A on road (calculated by dispatcher or estimated by fireman as distance from bridge to line of sight).
3. Proceeds on line A to X as determined by use of compass and known azimuth, pacing estimated distance to the fire.

Supplemental:

If fire were located at Z, the fireman would determine the direction from A to the fire by using the back azimuth instead of the azimuth.

Problem 2

Condition:

Same situation as in Problem 1, except Clear Creek is impassable except on bridge.

Action Required:

1. Fireman receives instructions from dispatcher and records same in notebook and on map.
2. Proceeds to bridge as in Problem 1.
3. Paces to fire on line B-X, using azimuth and distance (128 chains) as provided by dispatcher. Line used in this case is not lookout azimuth, but instead is plotted with a protractor by dispatcher.

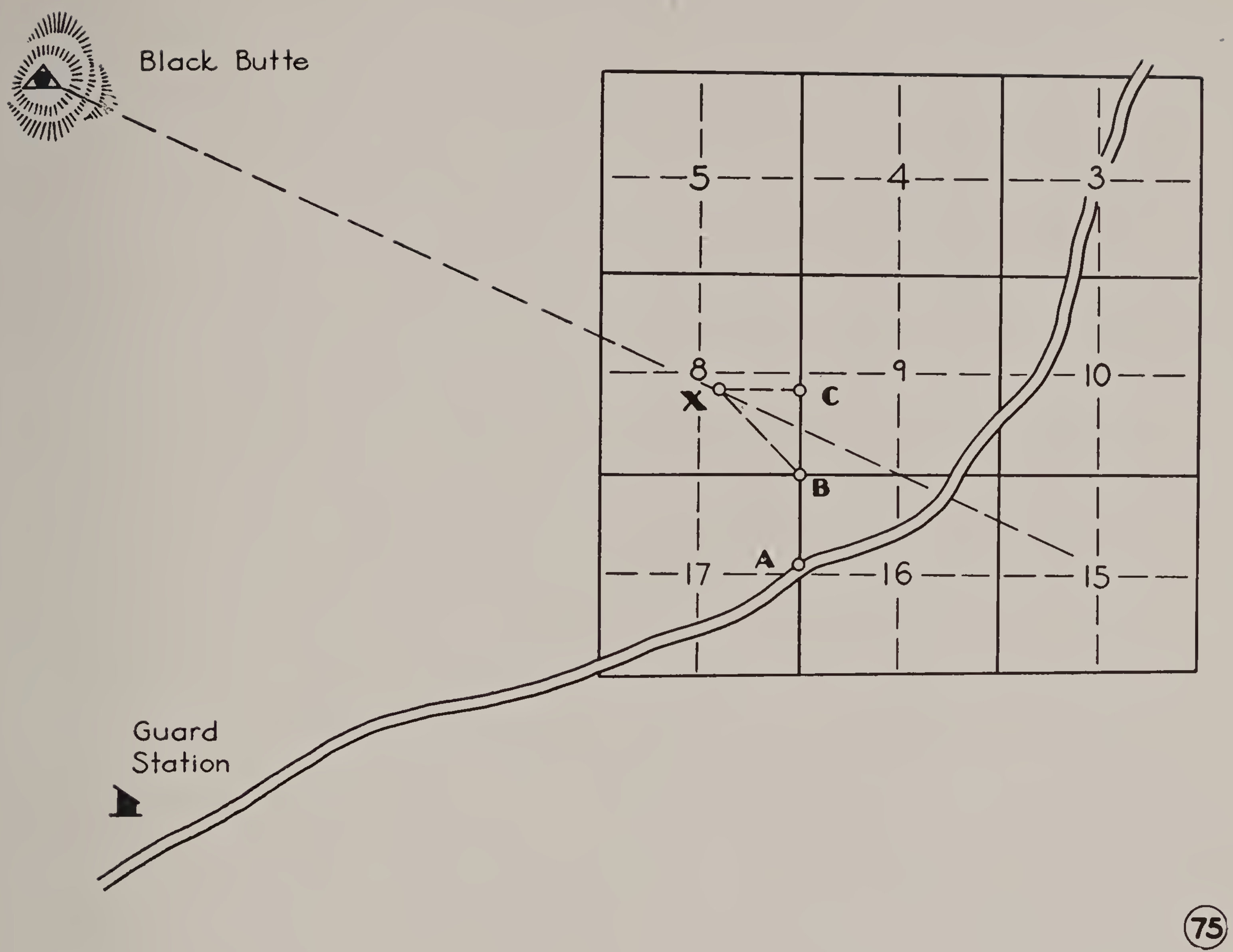
Problem 3

Condition:

Same situation as in Problem 2, except fireman finds brush field on line B-X to be extremely difficult and slow to hike through, but easily avoided.

Action Required:

Same as in Problem 2 to the bridge across Clear Creek. Fireman then paces down far bank of Clear Creek until he is able to get on line of sight as determined by back sight on Thomas Butte. He then proceeds on line of sight to fire, going a total of 140 chains. The additional 12 chains over the dispatcher's 128 chains is his own estimate of the effect of the detour.



Condition:

Fire located at X in surveyed country by Black Butte with cross shot. Small fire, probably difficult to find. Fireman knows where section line marker is at point A.

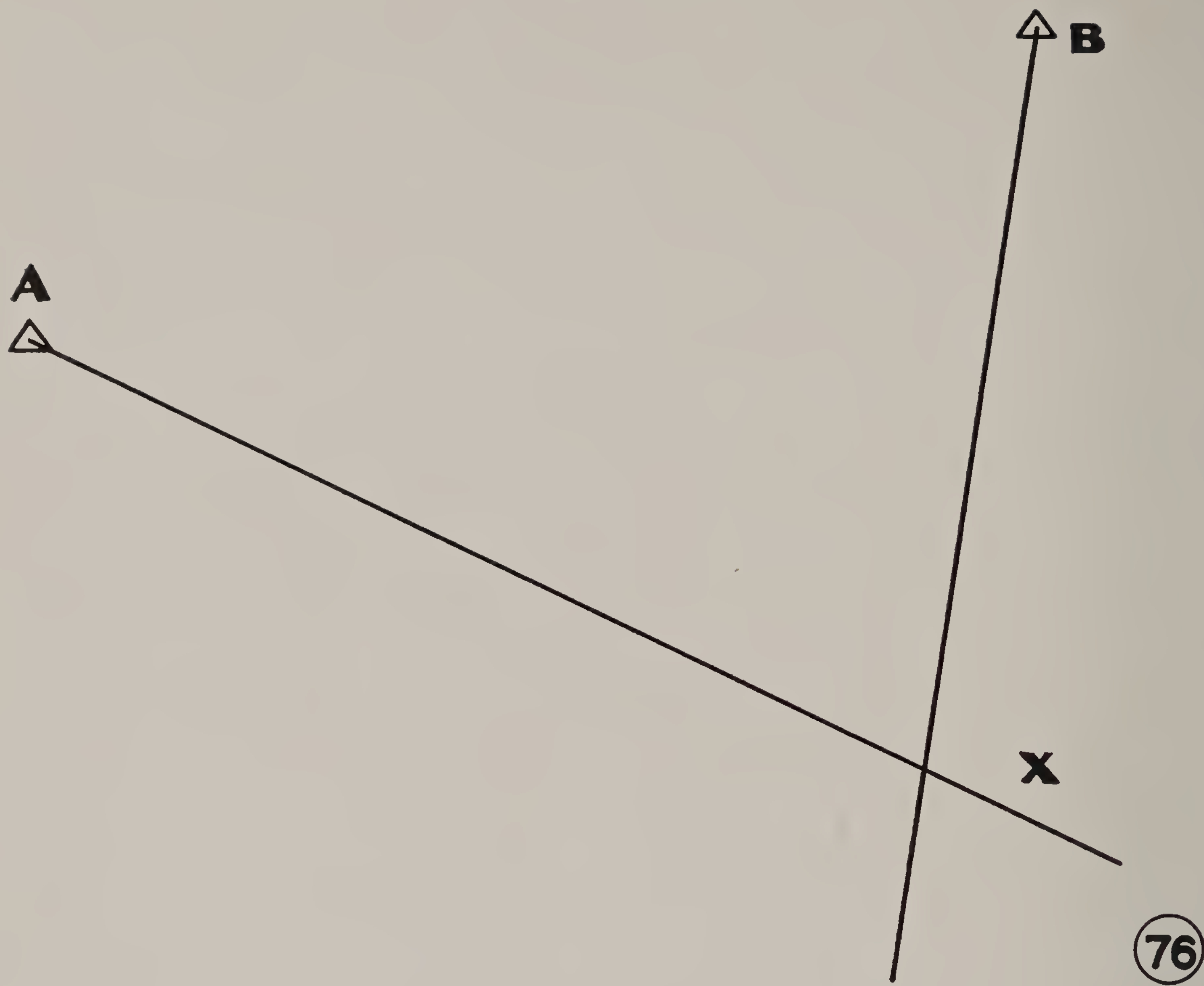
Action Required:

Fireman receives from dispatcher and carries out following orders:

1. Marks location of fire and line of sight on his map, writes down azimuth and back azimuth and other instructions.
2. Drives to marked roadside point A, which is on line between Sections 16 and 17.
3. Proceeds due north, pacing 38 chains to section corner at B.
4. Paces along line B-X on azimuth 319 degrees for 50 chains to the fire.

Alternative Course:

Paces due north 38 chains on line B-C, thence due west 33 chains to the fire.

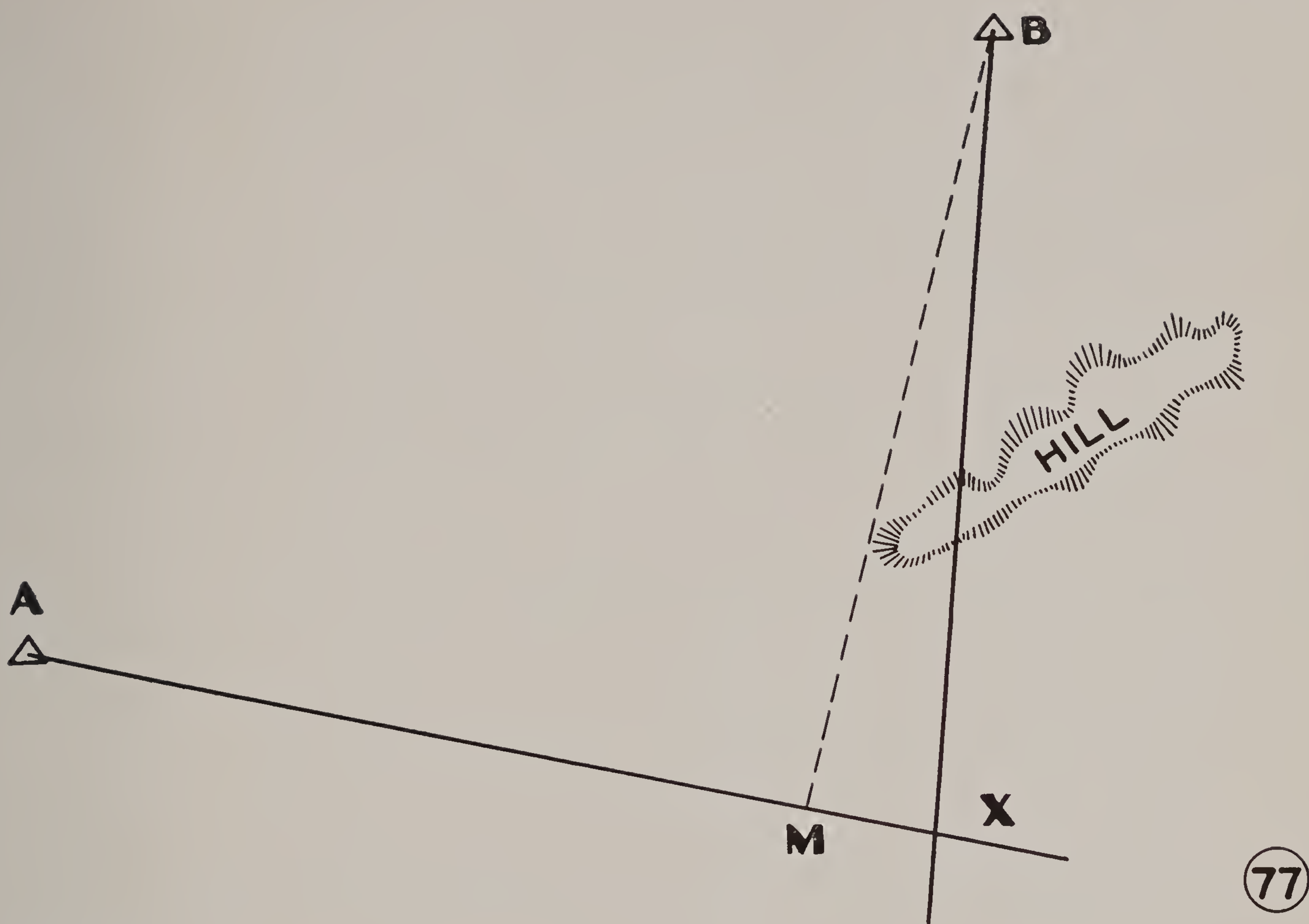


Condition:

Fireman has been dispatched to fire at X, located on map by intersection from lookouts A and B. Has full record of instructions, including map. Has become confused en route, can't find fire, and needs to check his location. Topography gentle. Lookouts can be seen.

Action Required:

1. Sets up compass and back sights on lookout A, changing position until correct back azimuth is read.
2. Proceeds similarly with lookout B, keeping on line of sight from A in the meanwhile.
3. When both back sights check with the back azimuth given him by the dispatcher, he will be at intersection indicated



Condition:

Same as in Problem 5, except that end of small hill prevents back vision to lookout B from vicinity of intersection.

Action Required:

1. Gets on line of sight from lookout A as in Problem 5.
2. Sets up compass on this line at a point where lookout B can be seen.
3. Reads back azimuth to B.
4. Obtains difference between this back azimuth and the true one provided by dispatcher (say 1½ degrees).
5. Measures distance in miles on map between B and X (say four miles).
6. Multiply 1½ x 4 x 92, which gives 552 feet as the approximate distance from M to X.
7. Proceed from M on lookout A's line of sight 552 feet to X.

NOTE: This solution is reasonably accurate when the angle between the lines of sight from the two lookouts is within 20 degrees of a right angle. For sharper intersections, measure on map distance B-M rather than B-X, and increase calculated distance M-X approximately as follows:

Approximate angle of intersection	Increase M-X.
65 degrees	11%
60 degrees	15%
55 degrees	22%
50 degrees	31%
45 degrees	41%

The Use of Azimuth Readings:

The azimuth of any point is the angle which the line (from the compass to the point sighted) makes with a north and south line when measured clockwise from the north. The numbering of the degree graduations on the azimuth plate are counter clockwise in order that the azimuth may be read directly.

Mistakes to avoid:

Reading wrong end of needle.
Not releasing or letting needle down on pivot.
Reading wrong side of numbered divisions, e.g., 61 degrees instead of 59 degrees.

Directions for taking back sight readings from a given azimuth.

1. When azimuth from lookout to fire is less than 180 degrees, add 180 degrees to azimuth reading.

   Example:

   Reading from lookout to fire—132 degrees.

   Therefore, back sight reading is 132 degrees, plus 180 degrees—312 degrees on compass.

2. When azimuth from lookout to fire is 180 degrees or more, subtract 180 degrees from azimuth reading.

   Example:

   Lookout reading from lookout to fire—310 degrees.

   Therefore. back sight reading is 310 degrees, minus 180 degrees—130 degrees on compass.

3. When the north end of the needle is on the azimuth, the south end points to the back sight reading.

Running Compass Line to Fire:

When you see the fire from a lookout point:

1. Open the compass and set it level on a stump or log with cover away from you.
2. Keep metals that attract the needle well away from the compass.
3. If the fire is higher, then you raise compass lid so sight from back of compass just passes over edge of lid. If the fire is lower than you, tip lid down so as to sight along white line.
4. Be sure the needle swings freely.
5. Turn the compass so that the white line on the cover points to the fire.
6. Let the needle settle and mark down the reading.
7. Pick out a foresight (some unmistakable object on the line between yourself and the fire which should not be lost from sight at any time while traveling to it).
8. Go to the foresight and set up the compass as before.
9. Turn the compass until the needle is fluctuating equally on each side of the azimuth reading.
10. Let the needle settle.

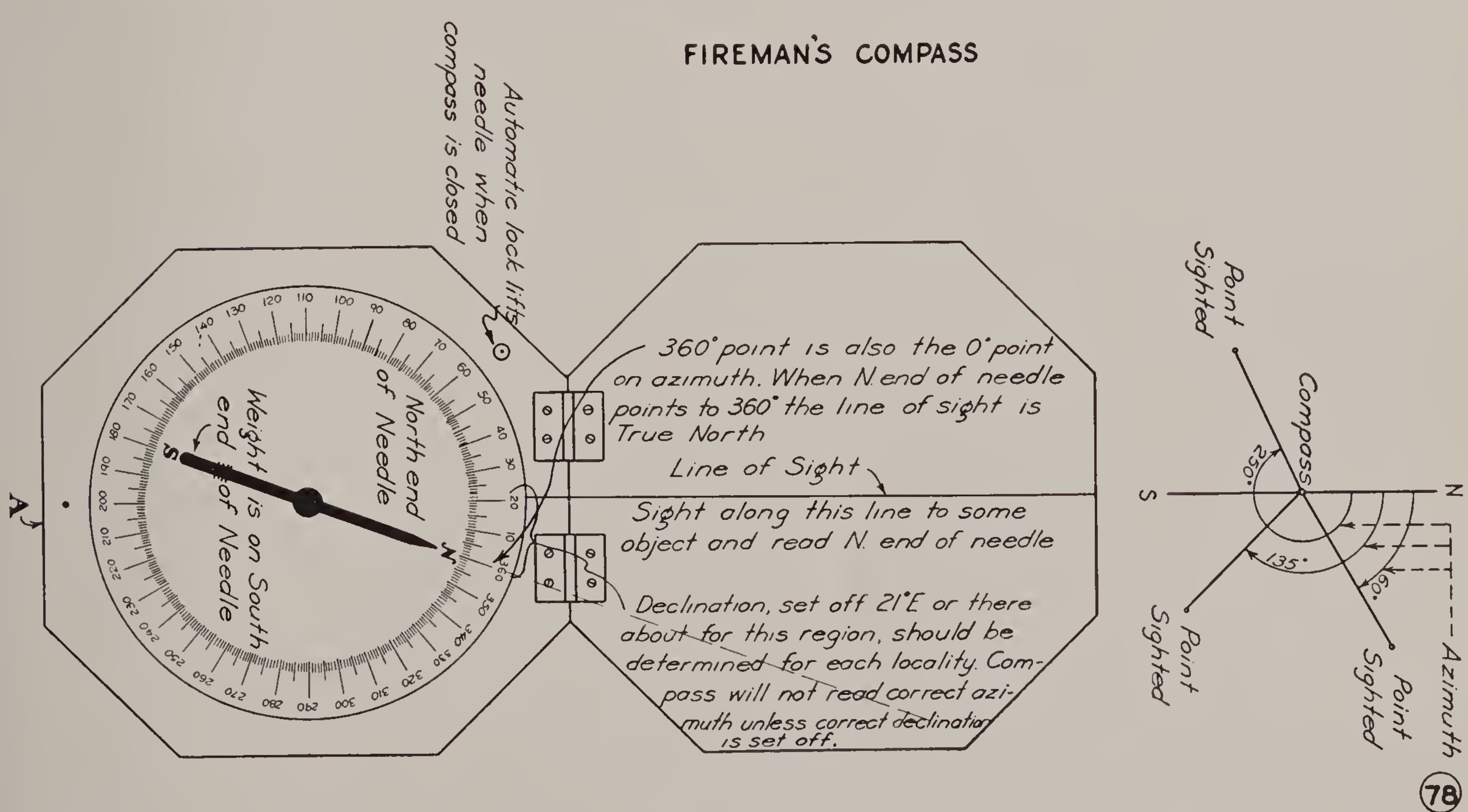
11. Turn the compass carefully to the exact azimuth reading which you marked down previously.
12. Sight along the white line on the cover and pick out another foresight.
13. Repeat the operation at each foresight until the fire is reached.

Getting on Line:

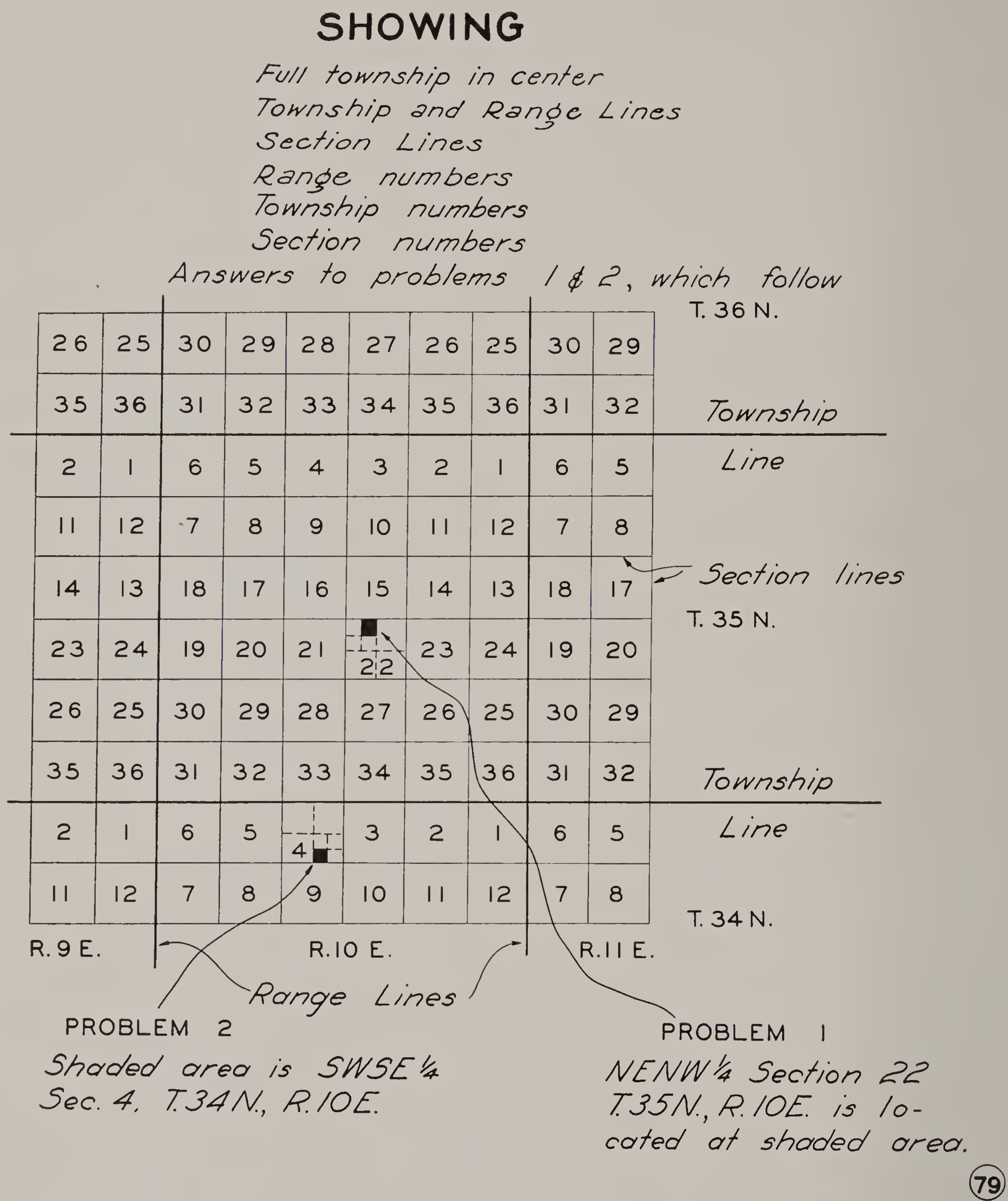
It is nearly always impossible to keep the lookout point in view when traveling to a fire. When the fireman reaches a point where the lookout point can be seen and wishes to get on line between the lookout point and the fire, he proceeds as follows:

1. Face general direction of back sight.
2. Set the compass firm and level as described previously.
3. Turn compass so *north end of needle* rests on back sight reading.
4. When the needle has settled on back sight, sight through the compass sights or along white line on cover.
5. Note on which side and the approximate distance the line of sight misses the lookout point.
6. If it misses to the left the observer must move to the right or vice versa.
7. Estimate the distance necessary, move over distance figured and set up the compass again. Repeat if necessary until the line of sight intersects the lookout point.
8. The observer is then on line between the lookout point and the fire and can turn the compass to the azimuth reading and proceed along the line toward the fire.

FIREMAN'S COMPASS



Locate a specified area on a map from a written legal description.



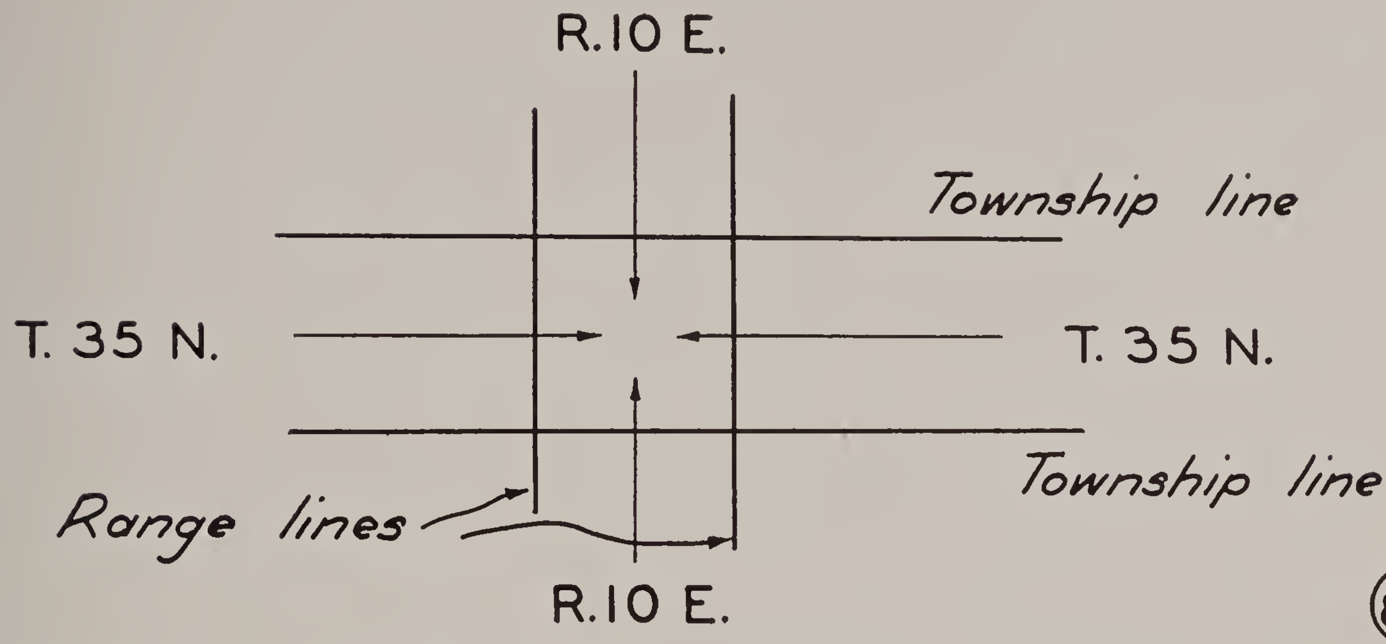
Condition:

Given the legal description: Northeast Quarter of Northwest Quarter, Section 22, Township 35 North, Range 10 East (NE¼NW¼, Sec 22, T. 35 N., R. 10 E.). Find this on the township plat.

Action Required:

1. On the map find the symbol T. 35 N. (This is usually on map margin.)

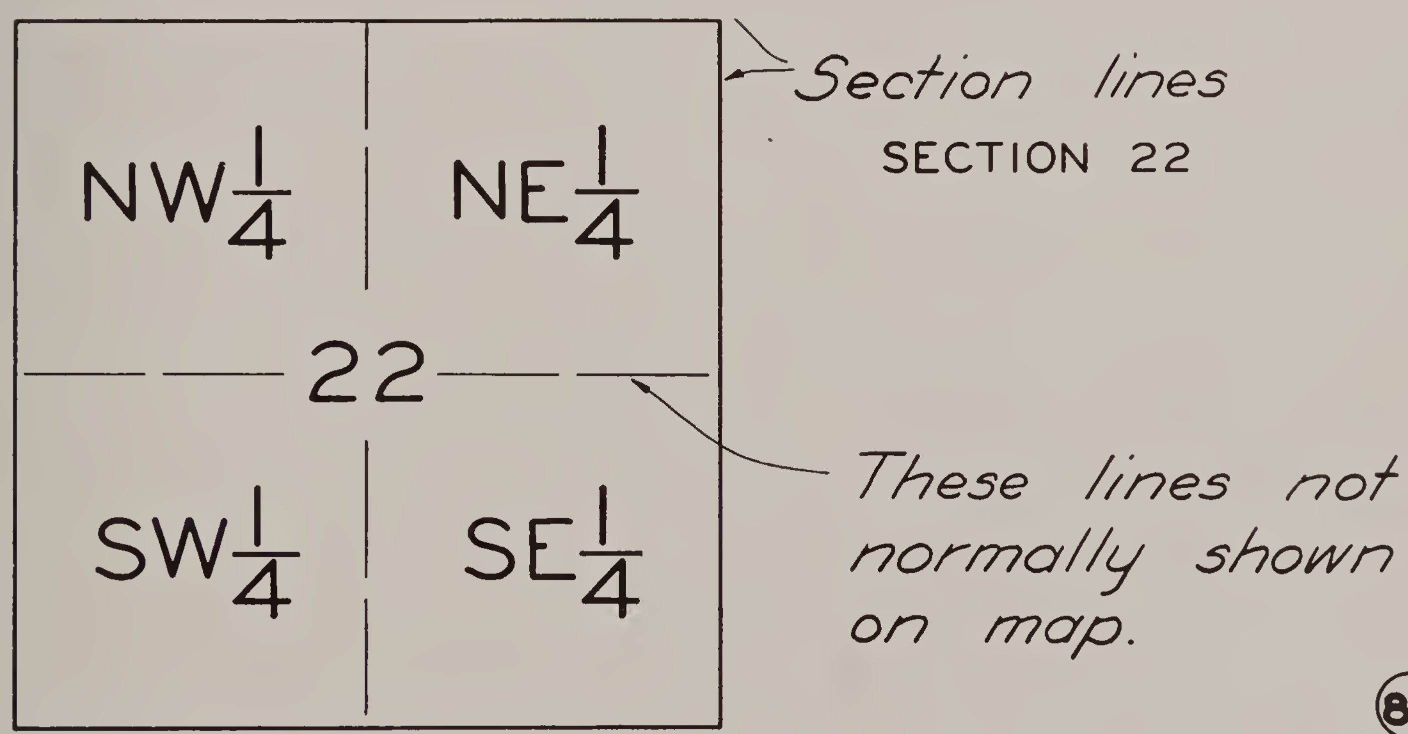
2. Follow across the map between the heavier horizontal lines until you are directly above or below a marginal symbol R. 10 E., as shown below.



80

This locates block T. 35 N., R. 10 E., on the map, which is called a township.

3. Locate Section 22 by referring to plat showing the sections numbered. (In some cases the sections are numbered, and this step is not required.)
4. The section is normally a square representing one mile enclosed by lighter lines than the township and range lines.
5. Smaller divisions: The section is divided into quarter sections which are not shown on field map, as follows:



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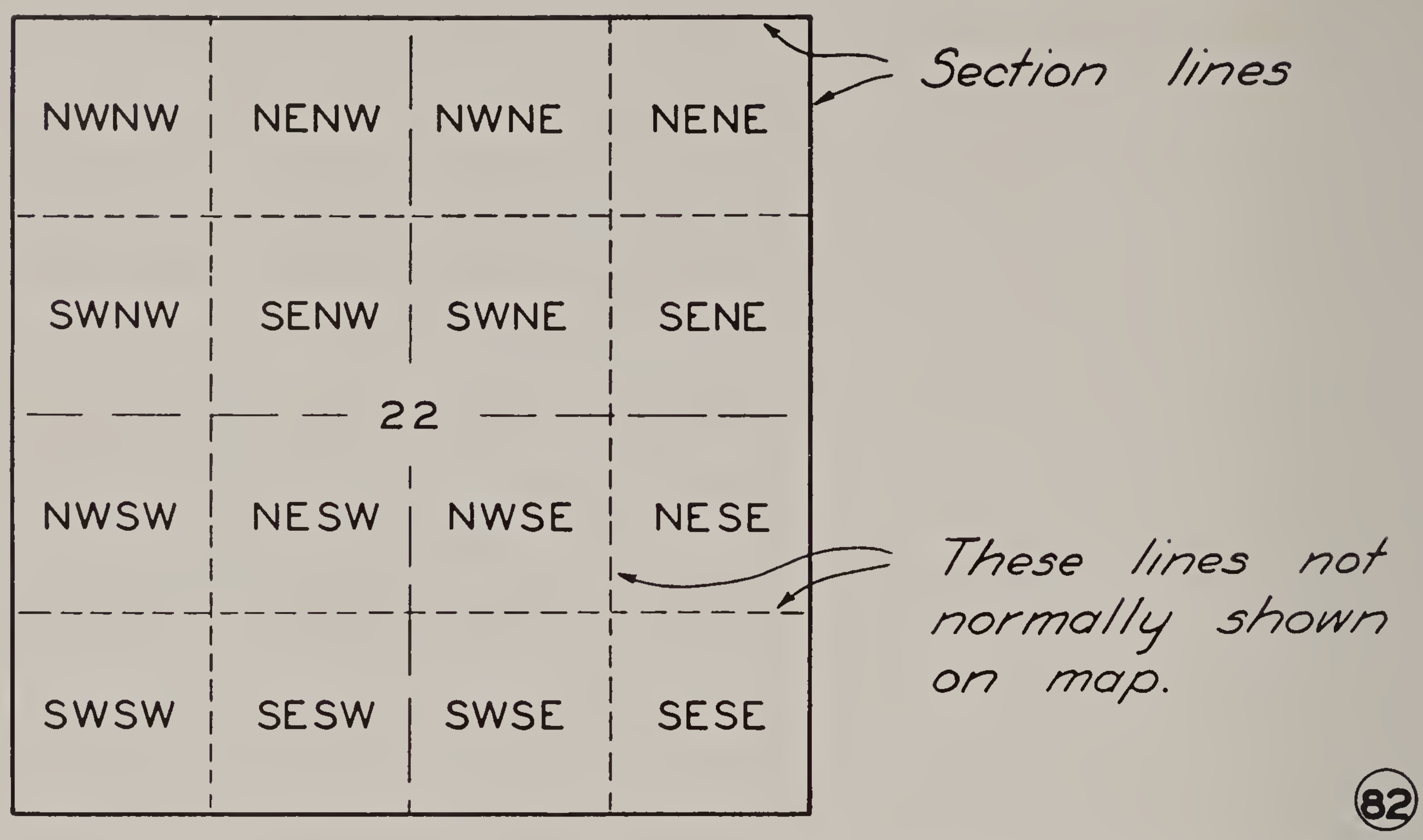
6. The quarter section may be subdivided further as shown below:



7. Then NE¼ OF NW¼, Sec. 22, T. 35 N., R. 10 E., is as indicated on township plat.

PROBLEM 8

Give the legal description of an area marked on the map.

Condition:

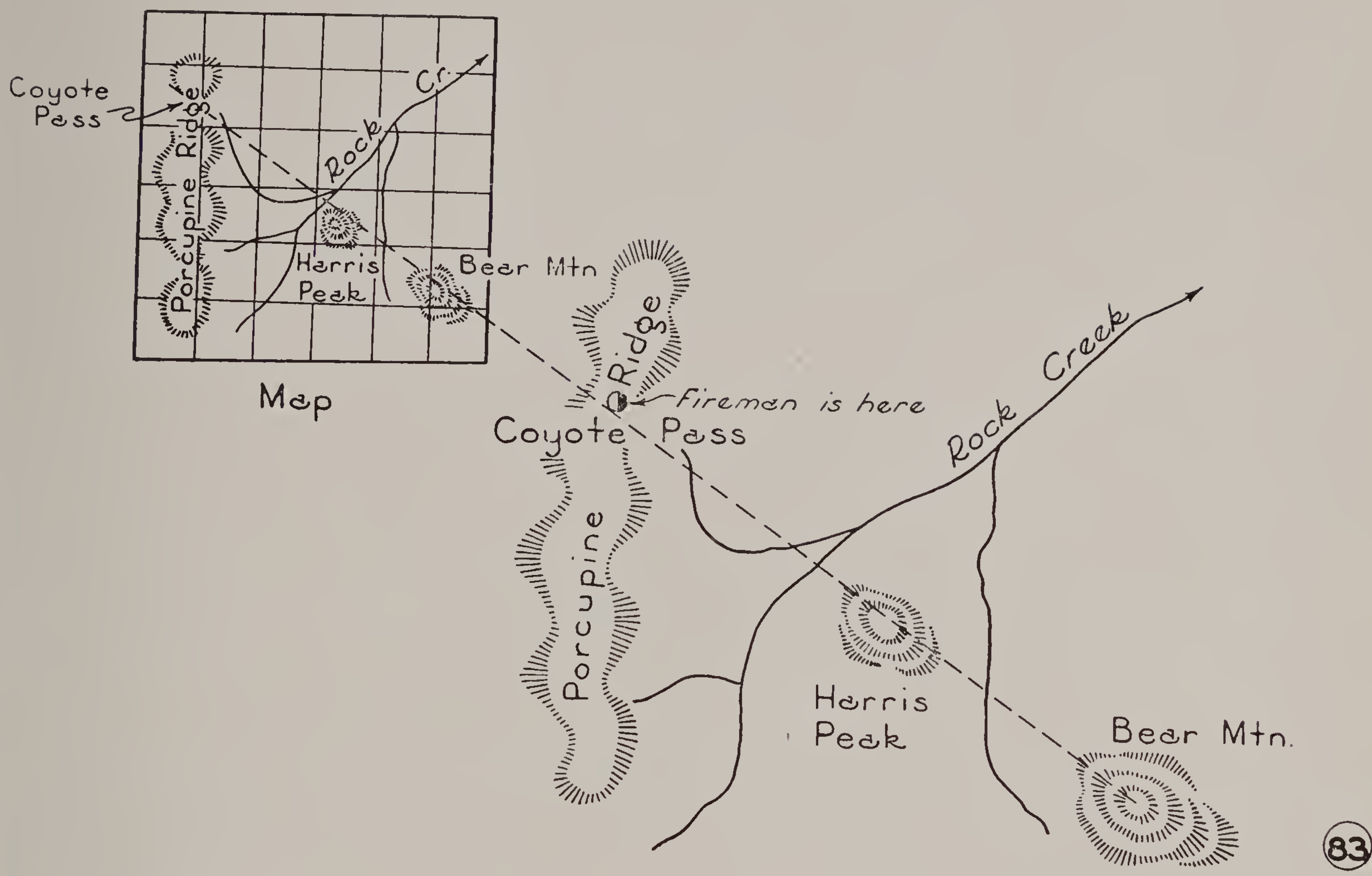
Area on map specified as shown on figure under Problem 7.

Action Required:

1. Follow out to margin and get T. 34 N.
2. Follow down to margin and get R. 10 E.
3. Count sections starting at Section 1 and going to the left horizontally and get Section 4.
4. Marked location falls in SE¼ of section and finally on the SW¼ of the SE¼.
5. Area then has the written description of:
   SW¼SE¼, Sec. 4, T. 34 N., R. 10 E.

Problem 9

Orienting fireman's map without use of compass.



Condition:

Fireman knows closely his location both on ground and map and is familiar with certain prominent peaks, ridges, etc.

Action Required:

1. Lay map out flat with top of map in general northerly direction.
2. Fireman knows he is at Coyote Pass.
3. By looking around the country, he identifies a peak—Bear Mountain.
4. He finds Coyote Pass and Bear Mountain on the map.
5. He shifts his map, until, when sighting over the map location of both Coyote Pass and Bear Mountain, the line of sight passes through Bear Mountain.
6. The map is then oriented approximately, and the fireman is then able to locate other landmarks from his map by taking into account direction and distances.

Problem 10

Condition:

Fireman does not know his location on ground or on map. He notes in looking over the country that from where he stands Harris Peak and Bear Mountain are in line. (Refer to diagram under Problem 9.) He is also able to tell he is somewhere on Porcupine Ridge.

Action Required:

1. He finds on the map, Porcupine Ridge, Bear Mountain and Harris Mountain.
2. He then draws a straight line through Bear Mountain and Harris Mountain on the map and extends it to intersect Porcupine Ridge on the map.
3. This line passes through Coyote Pass on Porcupine Ridge. The fireman's location is, therefore, at Coyote Pass.
4. His map can then be oriented by the method described in Problem 9.

Problem 11

Locating position on map with compass and protractor.

Condition:

Fireman does not know his location on map or on ground, but can identify two or more topographic features which are shown on his map.

Action Required:

1. Sets up compass and obtains bearings on both known features. (Selects two which nearest approach a 90 degree angle if possible.)
2. Converts compass readings into back azimuth.
3. Places center on hub of protractor over exact location of target with zero degree to north on map (0 degree and 180 degree line on protractor must parallel north and south line on map.)
4. Makes pencil dot on map to indicate where back sight crosses edge of protractor. Extends straight pencil line from target (on map) through dot indicating back sight.
5. Repeats procedure on second target. Point where lines intersect indicates exact position of fireman on map.

FIREFINDERS—DESCRIPTION AND USE

The firefinder is the instrument which the lookout uses to locate fires which are discovered from his station. Four kinds are in use.

Orienting Firefinders:

In orienting, first see that the mapboard is level and have the north end approximately north.

Place left edge of the alidade against the pin indicating your position on the map with the same edge passing directly over an accurately located peak. Move the board on the base until the line of sight, through the alidade, passes through that point on the ground. Clamp the straight-edge snug against the edge of the mapboard. The board is now in orientation as to that one peak, but should be checked by swinging the alidade until the left edge passes directly over another selected peak and sighting to see if that peak is intersected by the line of sight. The orientation must be checked on at least two peaks, and the differences, if any, compensating by splitting the amounts of error.

The principle of orienting maps with all firefinders is the same. The Bosworth and Osborne map bases and sights may be moved independently and each clamped when necessary by means of set screws.

The ranger will designate at least three peaks at each lookout which have proven reliable for orienting the mapboard. The names and bearings of these established

points must be posted in each lookout and must always be used in orienting the mapboard. He will also require that an orientation mark be established inside the lookout house and map or margin on firefinder designated so that the orientation can be easily accomplished during haze and fog, or at night.

Koch Finder:

The Koch firefinder has a base board supported by a post or tripod. The mapboard sits on the base board which is fitted with a straight edge against which the edge of the mapboard is placed. The straight edge is loosened at one end by a set screw and moved when orienting the mapboard. The map has an azimuth circle drawn on it and an 18 inch common alidade is used to take readings on fires.

Weholt Finder:

The Weholt is similar to the Koch finder except that the alidade is pivoted in the center of an azimuth circle on an Xylonite cover and the cover adjusted over the map so that the center of the azimuth circle is directly over the lookout point.

Bosworth Finder:

The Bosworth finder is all metal. The map is mounted on a round metal base and has the azimuth circle on a brass rim around the outer edge. The lookout point is the exact center of the azimuth circle.

Sights extending above the base at the rim are supported by an arm that rotates freely around the metal pedestal supporting the map base. They are connected across and above the map by a fine wire which intersects the lookout point in the center on the line out of sight.

The pedestal is set on a sliding base so that the whole map may be moved to avoid obstructions to sight. The map base rotates on the pedestal for orientation purposes and is clamped in any position with a set screw.

Osborne Finder:

The Osborne finder consists of a wooden base board fitted with steel tracks upon which the metal map base sits and may be slid to one end or the other to avoid obstructions to sight.

The map base of metal is round, and the sights are set in a metal rim around the outer edge, with the rear sight at zero of the azimuth circle. The metal rim is the azimuth circle, graduated in degrees and half degrees, and rotates around the map base. Readings are taken when graduations on the azimuth circle are in alignment with a vernier set in the base at the south side of the board.

The map is always mounted so that due south falls at zero on the vernier.

The sights are connected across and above the map by a light steel tape set on edge which intersects the lookout point in the center of the board. The tape is graduated in miles for determining distances on a half-inch map.

The rear sight has a sliding peep and the front sight two cross hairs for taking vertical readings. The rear sight is graduated in degrees for obtaining vertical readings. Instructions for taking vertical readings are stamped in the metal of the rear sight. The peep intersecting the upper cross hair gives a plus reading, the lower a minus. The vertical reading is not required except in special cases, which will be covered by detailed instructions from the ranger.

The Alidade:

The alidade is a ruler, with sights attached at the ends, used to sight various objects, usually fires. In sighting, either for readings on the azimuth circle or in orienting the mapboard, the left side of the ruler represents the line of sight and is placed against a pin inserted in the map at the exact point where the lookout is located. Using the left side prevents any of the degree numbers on the left being covered up. The sights on the Bosworth and Osborne firefinders are not primarily alidades and will be referred to as sights.

The 18-inch alidade is used with the Koch firefinder. The alidade used on the Weholt finder is pivoted in the center of an azimuth circle on an Xylonite cover which is placed on the map with the azimuth circle centered at the lookout point. The left side of the forward end of the alidade is cut out so that it coincides with the line of sight.

The rear sight on alidades and lookout boards have a lengthwise slot to look through, while the front sight is open with a hair, wire or thread stretched vertically through the center. Whatever material is used it is called the hair. The hair in the front sight must always be taut and straight.

Azimuth Circle:

The azimuth circle as used on lookout maps is a complete circle of 360 degrees, usually graduated in degrees and half degrees. Every 10th degree is numbered, the numbers proceeding clockwise around the circle.

The circle is drawn or placed on the map with its center exactly at the lookout point and graduated so that a north and south line through the lookout point passes through the zero and 180 degree marks, the east line intersects 90 degrees and the west line falls across 270 degrees.

In sighting a fire, after orienting the map, the alidade or sights are adjusted until the hair splits the location of the fire. Then by reading the degree number where the left side of the alidade (or the wire or tape connecting the sights) intersects the azimuth circle on the edge toward the fire, the bearing or azimuth reading of the fire is obtained.

The azimuth circle on the Forest Service smokechaser compass is graduated to 360 degrees but is numbered from zero or north, counter-clockwise. This arrangement facilitates obtaining readings that coincide with those taken at the firefinder, and will not be confusing after one has been trained in its use.

SEARCHING FOR FIRES

Adequate knowledge of territory and complete description of the fire location reduce search time. *When the vicinity of the fire is reached and the smoke is not seen:*

Check again on location given you and topography indicated.
Look for your landmark, previously picked out.
Climb a tree and look for smoke. Get back sight if possible.
Find a point where back sight may be taken on the lookout point and get on the line of the azimuth reading.
Search area each way along this line from reported location of fire.
Systematically cross section the area.
Smell out smoke by wind direction. Listen for crackling of fire.
Cross to another ridge or slope and look back.
Determine your own exact location on map by use of compass, map and protractor.

Do not mill around aimlessly in the area where the fire is supposed to be. There is little chance of finding the fire in this way. Take advantage of every opportunity afforded by topography to look around. Watch for ash flakes on leaves, logs, etc.

GRIDIRON METHOD

When the approximate location of a fire is reached, and the above methods of search have proved futile, a slower but more systematic method must be adopted. This is known as the compass gridiron method and comprises the systematic cross-sectioning of the area in which the fire is reported. For one man alone this means traveling in a nearly straight line from one side of the area to the other, offsetting to one side and traveling back to the end of the area from whence he started. The offset should be the distance which will permit his observation to slightly overlap the strip seen on his previous trip. This procedure is continued back and forth across the area until the searcher has assured himself that no fire exists in the territory covered, or until the fire is found.

When more than one man undertakes to gridiron an area, the person in charge places each man on a line facing the area to be searched, and proceeds as specified for the lone fireman. To avoid circling, which is inevitable on steep ground in heavy timber, the leader should carry a compass line throughout each crossing of the area. The spacing of crew members is regulated according to the density of timber or the difficulty of observation encountered.

While the organization and conduct of this method requires some time, it is the only known method by which we are assured that the entire area has been observed by a searcher.

ESTIMATING AND MEASURING AREAS OF FIRES

Everyone who extinguishes a fire must report the area of it. In order that areas of fires may be reported accurately, the following points should be kept in mind:

43,560 square feet	1 acre
10 square chains	1 acre
1 chain	66 feet

All land measurements or surveys are computed on a basis of horizontal or level distances. On slopes the difference between slope distance and horizontal distance varies with the steepness of the slope; the steeper the slope the greater the difference. Due allowance should, therefore, always be made for this difference when measuring up the area of a fire. A good way to check yourself on pacing steep slopes is to use a short stick of known length, five or six feet long, hold it in a horizontal position against your body and make a mark with the other end on the ground in front of you, then pace to this mark, measure again with the stick, standing on the first mark; repeat this operation up the hill.

The edge of a fire is generally very irregular and the shape is usually such as to discourage accurate measurement. However, small burned areas can be classified as circles, squares, triangles or rectangles, and as such staked off to be measured.

Some burned areas will be outside the area staked off to be measured and some unburned areas inside, but in staking out the area try to balance these up as nearly as possible.

The circular method of measuring areas is the easiest to use, if it can be applied. Having determined the boundary of a circle of the approximate area of fire, pace off the radius (distance from center to edge of circle). The following table gives

radius lengths from small fires of sizes most frequently handled by smokechasers:

A circle with a radius of 37 feet covers 1/10 acre.
A circle with a radius of 53 feet covers 2/10 acres.
A circle with a radius of 59 feet covers ¼ acre.
A circle with a radius of 64 feet covers 3/10 acre.
A circle with a radius of 83 feet covers ½ acre.

If the burned area more closely resembles a square or rectangle, mark out a boundary for it, balancing unburned area within your line with burned area outside. When satisfied that the area within your lines is of approximately the same size as fire, pace off the length and width of the area. *Measure these in chains* and multiply. This will give you the area in square chains, and as there are ten square chains in one acre, you will get the area in acres by dividing by ten.

Main Points to Remember:

1. Do not guess on area of fire. Measure it on the basis of a circle, triangle, rectangle or square.
2. If circle, measure radius (diameter from center to line) in feet and use table. Make note of length of radius if table does not give area for the radius obtained.
3. If square or rectangle, get the length and width in chains. Multiply these and divide by ten to get area in acres.
4. All fires less than 1/100 acre should be reported in square feet; larger fires in square chains or acres.
5. The average man steps about 2½ feet on level ground. Determine your length of pace on various slopes by actual measurement.
6. For squares and rectangles obtain length and width in chains. One chain—66 feet.
7. Length (in chains) x width (in chains) divided by 10 equal area in acres.

Estimating Perimeter of Fire From Lookout:

Occasionally the lookout is requested to estimate the perimeter of a fire a considerable distance away. This can be done by two methods:

First: By use of firefinder he can measure horizontal width (the cross-wide dimension). With this as a comparison gauge, he estimates the other dimension (the one extending along his line of sight). This gives him a square, rectangle, triangle or circle.

Second: When a firefinder is not available, estimate the height of trees in or adjacent to the fire. Then use these as comparison gauges. Ten trees wide, etc., and convert this to feet or chains to obtain dimensions.

A rule of thumb to be used on average fires is as follows:

The area in shape of a square:

Multiply length of one side by 6. If unusually irregular edge, multiply by 8.

For rectangular area:

Add width plus length and multiply by 3. Multiply by 4 if very irregular.

For circular area:

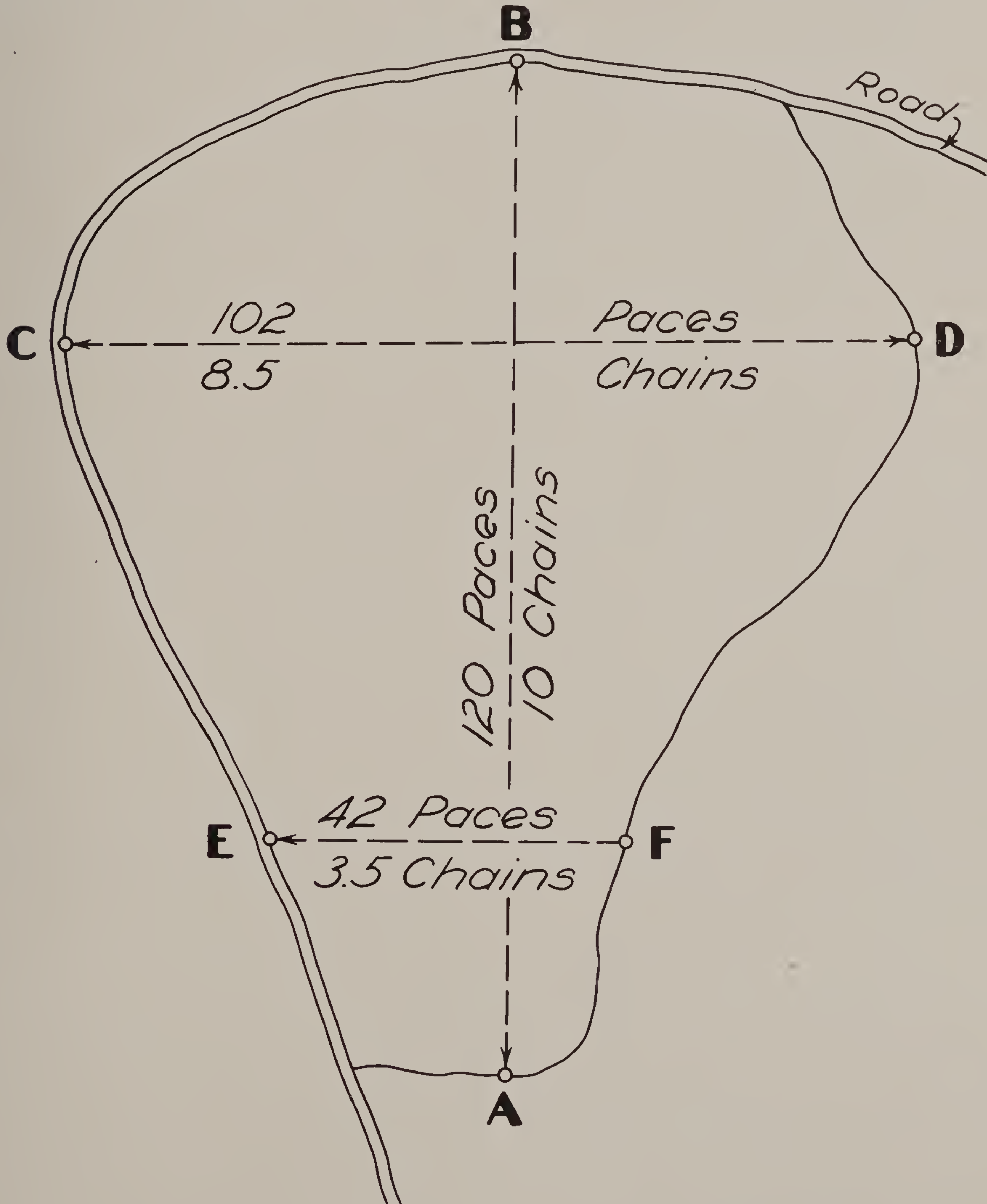
Compute circumference and add 50%. If very irregular double circumference.

The above rules of thumb may be used by firemen to estimate the perimeter of fires when they first reach them. Such an estimate is required on the fireman's report.

To determine acreage of fires 0.1 acre and over.

Condition:

The fireman, after his crew has mopped up the fire, walks around and through it to size up its general shape. While doing this, he keeps in mind that he wants to get its average dimensions by pacing distances, to be used in figuring out the acreage burned to enter on his fireman's fire report. He has previously practiced pacing over a marked course of a chain and has found that he takes twelve paces (double steps) to the chain on average ground. He draws a rough sketch of the shape of the fire on a notebook sheet, thus:



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Action Required:

He decided that the length of the fire is about the same any way it might be measured, so he paces the length following the line indicated as A-B on the sketch. He records the number of paces on his sketch, which, in this case, is 120 paces; or 120 divided by 12 equals 10 chains. He then paces across the widest portion of the fire approximately at right angles from his lengthwise paced distance; and records 102 paces, or 8.5 chains, as indicated by line C-D on the sketch. Going down to the other end of the fire, where it is the narrowest, he paces this distance and gets 42 paces, or 3.5 chains, which he records for the distance E-F. He then follows the steps listed below to determine the area:

(a) The average width equals the sum of the two measurements divided by 2.

3.5 chains—width of fire at E-F.

8.5 chains—width of fire at C-D.

12 chains—sum.

12 divided by 2—6 chains, average width.

(b) The area in square chains equals the average width times length.

6 chains—average width from step (a).

10 chains—average length.

6 x 10—60 square chains—6 acres.

Methods apply to 0.1 acre and larger.

PROBLEM 2

To determine the area in square feet of fires less than 1/10 of an acre.

Condition:

Guard gets a length of 14 paces and width of 7 paces.

Action Required:

1. Convert paces into feet, based on number of paces he takes to the chain.

Example: 12 paces—1 chain.

1 chain—66 feet.

Then one of guard's paces—1/12 of 66 feet—5.5 feet.

2. Multiply length in feet by width in feet, which gives number of square feet.

Example: (a) One of guard's paces—5.5 feet.

(b) Length 14 paces. 14 x 5.5—77 feet.

(c) Width 7 paces. 7 x 5.5—38.5 feet.

(d) Area of fire in this example:

Width x length—area.

77 x 38.5—2964 square feet, which should be rounded off to 3000 square feet for the report.

(Caution: A fire 10 feet by 10 feet is sometimes spoken of as "fire 10 feet square," but its area is 100 square feet.)

RECORDING LIGHTNING STRIKES

1. Mount a strip of thin white cardboard over map and under the metal azimuth rim and allow to extend 1¼ inches inside of the azimuth rim. Pencil lines in direction of lightning strikes with time and distances, will be recorded on this strip.
2. Upon appearance of a lightning storm, see that firefinder is ready.
3. Have clock in position for reading from finder.
4. Face storm across firefinder and point sights in direction of storm.
5. Have pencil in writing hand ready for action.
6. When a strike appears quickly line up sight, draw line on cardboard strip toward the strike along line of sight, and record time to nearest half minute.
7. When storm has ended ascertain azimuth, time of each strike and location of each strike and report to dispatcher.
8. By platting azimuths of strikes reported for the same minute, the dispatcher can obtain intersection locations and thereby quite accurately locate the strike.
9. Thunder is simultaneous with the lightning at the location of the strike, and sound travels one mile in approximately five seconds. If a clock or watch cannot be read directly for number of seconds between strike and sound of thunder, the period may be determined by counting from time of strike until the thunder is heard. By beginning the count, thir-teen, four-teen. fif-teen, etc., and by practicing and checking with the clock, satisfactory accuracy is attained.
10. Assuming the count started at thirteen when the lightning flash was seen, and ended at forty-two when the thunder was heard, subtract twelve from forty-two, which leaves thirty, or number of seconds. Divide thirty by five and you have six, or the approximate number of miles from the observer to location of strike. Scale off six miles in direction of strike and you have approximate location of strike. (The reason for starting the count at thirteen is that all numbers above thirteen have two or more syllables, and count of such numbers requires about one second.)
11. The method for determining distance from observer along a line of sight to the strike permits any single lookout, or the dispatcher, to locate a strike by use of an azimuth and scale. This method is also a very good check against the use of two or more azimuth readings and the intersection method.
12. Generally, location of lightning strikes are calculated by the dispatcher who uses two or more azimuth readings from different observers on the same strike. These readings are platted on a map and the location of the strike is determined to be at the intersection of these lines. The correct location will be reported back to the lookouts concerned.

INSTRUCTIONS FOR AIR DELIVERIES TO FIRES

SELECTION OF SITE (ON THE GROUND) FOR DROPPING OPERATION

1. Select a spot easily described. If possible, it should appear different than immediate surroundings. Peculiar topographic or vegetative features serve well as identification marks. Examples: Grass meadow, small clump of green trees, an alder thicket, rock slide, high point on ridge, etc.
2. Select site behind or alongside the fire, not under smoke drift.
3. First choice, ridge top; second, a wide, straight valley bottom; and as last resort, use sidehill.

DESCRIBING SITE

1. Positive identification of the exact site is necessary and can be accomplished through a carefully written description including:
   - (a) Quarter section, section, township and range.
   - (b) Whether ridge top, saddle, valley bottom or sideslope.
   - (c) Major landmarks; forks of stream, proximity and direction of outstanding features, lakes, peaks, saddles, etc.
   - (d) Direction and distance from main fire.
   - (e) Exact description of marker to be used.
   - (f) Character of ground cover, old burn, meadow, rockslide, etc.

MARKING SITE

1. A white cross made by two strips of cloth, paper or flour two feet wide by ten feet long, placed on open ground or on top of bushes, reproduction or weeds, serves best. Fasten it down with rocks, stakes or string to prevent disarrangement by wind or dropped packages.
2. When cloth, paper or flour are not available, use signal smokes as follows:
   - (a) Build two fires sufficient to throw smoke above tree tops, one to be 100 feet on each side of dropping site.
   - (b) Locate at right angles to wind to prevent smoke from merging as one.
   - (c) Have fires hot at least one-half hour before plane is to arrive.
   - (d) When plane is heard, place green boughs on fire to increase smoke volume.
   - (e) Keep smokes going strong until last package is dropped.
   - (f) A man waving a white cloth at the dropping site will expedite identification of the correct location.

RECEIVING PACKAGES

1. Station one or two alert men on vantage points preferably protected by a large tree or sheltering rock near the marker (within 300 feet) to record the location of bundles dropped. Each should carefully count the bundles as they are released to insure against loss.
2. Bundles may be dropped with or without parachutes. Do not permit ground crew to be on dropping site until plane signifies it has completed dropping. It is dangerous. Never station men *below* dropping site on steep ground.

REQUESTING AIR DELIVERY

1. When ordering air delivery always report the following:
   - (a) *Complete* description of dropping site as listed in "Describing Site" and "Marking Site."
   - (b) Time delivery at site desired.
   - (c) Size of outfit desired—in multiples of five-man units. Standard cache units are for twenty-five men, but special outfits will be prepared when ordered.
   - (d) Whether equipment, beds, subsistence or all are required.
2. Afternoon orders for air delivery must be received in Missoula in time to permit ships to return before darkness of night arrives. Best conditions for dropping prevail during morning hours or before 2:00 p.m.

3. A report indicating the condition of equipment and supplies delivered will be sent to the office of fire control as soon as convenient after the dropping is done.

INSPECTION

One of the most important phases of fire control administration is inspection. By inspection is meant the check-up and measurement of performance and facilities. Inspection is necessary to discover weak points in organization and things, and to prescribe means by which such inadequacies may be corrected. Likewise, inspection is designed to disclose things which are better than standard in order that such betterment may be put into general practice, and to make possible assignment of credit for outstanding performance.

Inspection is the responsibility of every person directing the action of another, or others, in any phase of fire work. It extends on through every position up to the chief's office. Each officer responsible for the performance of others must inspect the activities of his subordinates to ascertain whether instructions are being adhered to, and to measure results. Inspection must be highly exacting and impersonal in nature. It must be human and must be constructive if it is to be effective. Every inspection should have as its goal the objective of making the inspectee better qualified to do his work and to raise the standard of both morale and production. The inspectee can greatly increase the value of inspection by voluntarily presenting his problems, mentioning the parts of the job which cause him difficulty and asking questions.

The following summary of inspection practices should govern all fire inspections in the region:

1. Inspection will be exacting and thorough, but must not be such as to antagonize or tend to tear down.
2. The purpose of inspection is to assist inspectee in correcting faults rather than to criticize as matter of discipline.
3. Training must be kept in the foreground of all inspection, and can be accomplished by demonstration, drill and discussion.
4. Inspections to be constructive must not be routine, mechanical or stereotype. They must consider local influences and elements.
5. Outlines should be used as guides, or reminder lists, but must not be allowed to make inspections routine.
6. Copies of inspection reports or memoranda will be left with the inspectee, and should be discussed between inspector and inspectee.
7. Self-inspection by guards is essential as a weekly check-up on preparedness and performance.
8. Inspection should take nothing for granted. Examine, drill, test and instruct. Leave nothing to chance that can be definitely measured, or provided to make the job standard in quality.

Standard Region One inspection forms are shown on following pages.

GUARD'S WEEKLY SELF-INSPECTION CHART

(To be used by all guards in checking their station.)

A. Personal.

1. Appearance.
   Clean.
   Neat.
   Shaven.

2. Personal equipment required.
   (a) Watch.
      Keeps correct time.
      Checked daily.
   (b) Correct footwear and work clothes for firefighting.
      Suitable.
      In repair.
   (c) Uniform, hat and badge.
      Standard.
      Presentable.
   (d) Knife.
   (e) Food supplies.
      Sufficient for specified period.
      Needs listed.
      Orders placed.
      Properly stored.
   (f) Personal illness or injury reported to ranger.
   (g) Fire pack (Fire equipment).
      Adequate.
      Contents checked and complete in accordance with forest standards.
      Replenished after use on fire.
      Ready to take to fire.
      Water bag soaked.
      Canteens.
         Condition of cover.
         Condition of cap.
         Full of water.
      Backpack pump.
         Full of water.
         Does it leak?
         Gasket in cap.
         Does pump work freely or is barrel gummy?
         Shoulder straps O.K.
         Condition of hose.
      First aid kit complete.
      Cutting tools sharp.
         Handles tight.
      Candles wrapped in paper.
      File wrapped in paper.
   (h) Diary or daily log.
      Proper form.
      Up to date.
   (i) Job list.
      Supplied.
      Followed.

B. Station Buildings and Grounds.

1. Appearance and sanitation.
   (a) Interior neat, clean, orderly.
   (b) Windows clean.
      Towels or clothing hang over windows.
   (c) Dishes washed and put away.
   (d) Stove polished.
   (e) Bed made neatly—aired.
   (f) Garbage can clean.
   (g) Grounds clean and neat.
      Woodpile stacked — 2 weeks supply.
      Chips raked up.
      Trash, cans, rubbish disposed of currently.
   (h) Extra supplies neatly shelved and racked.
   (i) Manure disposed of currently where horses or livestock kept.
   (j) Garbage pit.
      Used.
      Cover tight.
      Disinfected.

2. Fire prevention.
   (a) Stovepipe.
      No holes.
      Joints and elbows tight.
   (b) Spark arresters.
      On chimneys.
      In repair.
   (c) Stove boards.
      Under stove.
      Between stove and walls.
   (d) Woodbox.
      No rubbish.
      Away from stove.

(e) No fires started with kerosene or gasoline.
Matches in glass or tin container.
(f) At least 5 gallons water on hand.
(g) Roof and gutters and behind chimneys clean of leaves and needles.
(h) Hazards cleared from around all buildings.
(i) Gasoline and oil stored outdoors away from buildings.

3. Improvements and facilities.
(a) Water system.
Adequate—clean.
(b) Station fences, corrals and gates.
Stock tight.
In neat repair.
(c) Other station buildings, sheds, etc.
Weather tight.
Theft proof (kept locked).
Needed repairs listed on job sheet.
(d) Station signs and posters.
Replaced when necessary.
(e) Lookout lightning protection.
Good condition.
(f) Flag.
Put up in morning.
Take down in evening or when leaving station.
Needs replacement.
Flag pole firm, but not set on building.
Rope satisfactory.
Rope tied to avoid loss of end through top pulley.

C. Transportation.

1. Automobile or truck.
(a) Motor clean.
(b) Oil proper level in crank case.
(c) Radiator full of water.
(d) All tires in good condition.
(e) All tires inflated.
(f) Spare tire in good condition and inflated.
(g) Tools to change tires.
(h) Gasoline tank full.
(i) Brakes effective.
(j) Lights will work.
(k) Battery charged—full of water.
(l) Recently greased.
(m) General condition.
(n) Required firefighting tools, including filled canteen and emergency rations, in car.
(o) Located for quick getaway.

2. Horses or mules.
(a) Good condition.
(b) Shod—shoes tight.
(c) Kept up during specified hours.
(d) Equipment.
In repair.
In place.
Saddle and blanket clean.
Ready to go.

D. Equipment.

1. Backpack pump.
(a) Full of water.
(b) Does it leak?
(c) Gasket in cap.
(d) Does pump work freely or is barrel gummy?
(e) Shoulder straps O.K.
(f) Condition of hose.

2. Canteens.
(a) Condition of cover.
(b) Condition of cap.
(c) Full of water.

3. Gasoline lantern.
(a) Is bowl tight and without makeshift plug?
(b) Does pump work?
(c) Are mantles O.K.?
(d) Spare mantles.
(e) Spare generator tip.
(f) Tools for lantern.
(g) Extra fuel available.

4. Tool grinders.
(a) Are they worn out of shape?
(b) Are they cracked?
(c) Condition of mandrel.

5. Files.
   (a) Are they worn out?
   (b) Handles provided.
   (c) Supply adequate.
6. Headlamps, electric.
   (a) Batteries in container.
   (b) Batteries in container shielded.
   (c) Condition of cord.
   (d) Spare bulb.
   (e) Will lamp work?
   (f) Extra battery supply.
7. Improvement tools.
   Check same as for fire equipment.
8. Osborne and Bosworth fire finders.
   (a) Oriented with respect to topography.
   (b) Sights plumb.
   (c) Sighting hairs tight.
   (d) Map oriented with respect to azimuth graduation.
   (e) Fire finder level.
   (f) Condition of map.
   (g) Carriage oiled.
   (h) General condition of instrument.
   (i) Orientation record posted and available for use.
9. Telephone.
   (a) Connections tight.
   (b) Protection blocks clean.
   (c) Telephone call chart up.
   (d) Ground O.K.—soldered.
   (e) Remote telephone switch O.K.

SPECIAL FIRE CONTROL EQUIPMENT

Recognition must be given to the importance of equipment in fire control work. Even the most highly skilled worker is ineffective without equipment. He is partially effective if his tools are partially adequate. He is fully effective only when provided with suitable tools. The region provides the best equipment available, since experience has taught that men are only as efficient as the tools they work with. Furnishing good equipment is only one important step in preparedness. Proper care and condition of these tools throughout their life is the second and perhaps most important part of the equipment problem. The finest axe is worthless when dull. A sharp axe is useless when it flies off the loose handle and lands inside the fire. Each employee is personally responsible for keeping equipment placed in his charge in the best possible condition. With facilities now available, there is no excuse for poorly conditioned equipment.

Following are some of the common things to do and watch for in caring for equipment:

Inspect each item before fire season. Test each item. Check against standard list for completeness. Keep in units. Use signs to distinguish. Store for: convenience in quick loading, minimizing possibility of mix-up in loading out, protection against weather, rodents, theft. Maintain in neat, attractive condition at all times. Business-like appearance of equipment builds morale and cultivates interest.

FIRE OUTFITS

Equipment and mess outfits in Region One are standardized to avoid confusion during inter-forest use. Prepared ration units are likewise standardized. Errors in transmitting and interpreting requisitions are reduced by using one common name for each particular unit. Dispatchers are required to use names defined in the following glossary:

Fire Equipment.

Name to Use in Ordering. *Description of Item.*

100-Man Outfit—New mess kit for 100 men. Tools same as two standard 25-man outfits plus *two* supplemental 25-man outfits. Can be used as two separate 50-man units. One hundred and ten beds in outfit.

50-Man Outfit—Consists of *one* standard 25-man outfit *plus one* supplemental outfit. Fifty-five beds. *Cannot* be split into two separate units.

25-Man Outfit—Regular R-1 standard, mess, tools, and bed unit complete. Thirty beds. (Only two crosscut saws will be sent with each 25-man outfit going to eastern forests.)

25-Man Supplemental Outfit—To be used in building up standard 25-man outfit to 50-man capacity. Eliminates duplications which occur when two standard 25-man outfits are used together. Twenty-five beds.

Eastern Supplemental Tool Package—With each 25-man outfit sent to the eastern forests, a supplemental tool package will be included. This package consists of 4 ladies' shovels, 4 pulaskis, 6 water bags—five-gallon man-pack.

1 to 15-Man Backpack—Outfits designed to fully equip units of 5, 10 or 15 men for backpack trips to fires. Includes rations for one day. Can be ordered in 5-man units if desired.

Fireman Pack—Tools and equipment for one man. Rations for one day.

Plow Unit—Standard R-1 unit. Specify if horses are desired. One day's grain and hay will be shipped when horses are ordered.

Pump Unit—Includes Pacific pumper, accessory box, 1,500 feet of hose and ten gallons of gasoline.

Telephone Communication Kit — Includes one standard wall telephone, batteries, arresters, ground rod and take-up reel.

Radio—Type M—Includes long-range receiver and transmitter, complete with antenna and accessories. Generators are required if used away from commercial power lines. Specify if generator is needed. Operators will be sent with all radio equipment unless otherwise specified.

Crew Fire Rations

30-Man One-Day Rations—Sufficient food to feed 30 men for two days. Not suitable to feed 60 men one day since it consists of four hot meals and two double-sack lunches, all varied. *Order kind of bread desired*—fresh, canned or without either.

Emergency Travel or Spike Camp Lunch—One box containing lunch, coffee, cups and can in which to make coffee for 30 men. Designed for use when a better meal than the sack lunches is desired. Okay for quick first meal in fire camp or for use in hauling men long distances. Rations *will be furnished* with fresh bread *unless otherwise specified*. Zwieback will be furnished for rations to be put in storage.

100-Man Ration Follow-up—A follow-up ration for use after the first day or two on fire. Contains staple food, such as meat, potatoes, canned foods, dried vege-

tables and fruits, etc. Enough for 100 men one day. *Order bread separately.* (Itemized list shown later in this chapter.)

200-Man Ration Follow-up—A ration prepared for use in large camps after the first day or two. Suitable for 200 men one day, or 100 men two days. *Order bread separately.* (Itemized list shown later in this chapter.)

Airplane Delivery Meals—Any standard ration unit will be dropped with parachutes as requested. For spike camps or over-night crew stops on the line where mess equipment is not available or desirable, order emergency travel or spike camp lunch. Lunches sacked and ready for use will be dropped upon special request.

Fire Commissary Box—Tobacco, gloves, socks, etc. Twenty-five men.

Open-Stock Supplies—Itemized list on Form R-1 8. Provide open-stock subsistence as early as practicable—better liked and cheaper.

(All outfits described above are itemized in Section 4, Fireman's Guide.)

DESCRIPTION OF OUTFITS

100-Man Outfit:

Tools and work equipment comprise two standard 25-man outfits and two 25-man supplemental outfits. This provides 110 beds. The only difference between this and two 50-man outfits is that a mess kit is used which greatly facilitates preparation of meals in large camps. Cooking utensils are of large capacity. Nested boilers are used instead of increasing the number of small kettles or buckets. These outfits should be ordered when it is known that camps of 100 or more men will be used. Can be split into two 50-man units if necessary. Cannot be broken down into 25-man outfits.

50-Man Outfit:

Consists of one standard 25-man outfit, plus one supplemental outfit. 55 beds. This unit is preferable to one-half of a 100-man outfit for use by crews of 30 to 60 men, since cooking outfit includes utensils which are better adapted by size and design for feeding crews of this size. Cannot be split into two 25-man units. Certain items necessary to operation of separate camps are not provided in duplicate.

25-Man Outfit:

The standard 25-man outfit is a complete tool and camp unit designed to fully equip a crew of 25 men. It includes 30 beds. The extra five beds are to provide for overhead, transportation men, etc. The tools provided are of such variety as to meet the need of any fuel type encountered in Region One.

25-Man Supplemental Outfit:

In equipping crews of more than 25 men, the supplemental 25-man units should be used. These units are prepared and ready at central warehouses, and their use with the standard 25-man tool and mess layouts eliminates duplication of such items as clocks, grinders, etc. When ordering be sure to state whether you need the regular 25-man unit, the 25-man supplemental unit or a combination of both.

Eastern Supplemental Tool Package:

This package of equipment is added to each 25-man outfit sent to eastern forests. Its purpose is to increase the number of digging tools to a higher ratio with clear-

ing tools. This is necessary in view of light clearing job in the more open fuel types of eastern Montana. With each 25-man outfit sent to the eastern forests, a supplemental tool package will be included. This package consists of 4 ladies' shovels, 4 pulaskis, 6 water bags—five-gallon man-pack.

One to 15-Man Backpack Outfit:

This backpack outfit is assembled in three units, each adequate for equipping a crew of five men. Likewise, packs number 1 to 10 are satisfactory for a 10-man crew, and the complete outfit is designed to equip a crew of 15 men and give them rations for one day. Additional rations may be added if desired. Pack No. 1 is suitable for equipping a single smokechaser.

1-5-10-15-Man Outfit

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Axes, D.B., 3½ lb., with light sheath		1					1					1			
Bags, 2-gal., water	1					1					1				
Bags, 5-gal., water, man-pack		1					1					1			
Buckets, tin, 6-qt.				1					1					1	
Batteries, No. 950	6			6		6			6		6			6	
Canvas manties, lightweight, for cargoing	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Compass, box, pocket	1														
Cups, tin, nested				5					5					5	
Canteen, 1-qt., Army		1					1					1			
Files, 8", for axe or saw	1			1		1			1		1			1	
Kits, small, medical		1					1					1			
Maps, smokechaser size	1					1					1				
Pack frames, Clack	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Electric headlights	1			1		1			1		1			1	
Pumps, hand, with hose		1					1				1				
Rations, 1 man-day	1	1	1	2	2	1	1	1	2	2	1	1	1	2	2
Saws, 4½', S.C., with sheath and handles			1					1					1		
Saws, 5½', with sheath															
Shovels, det. handles or lady	1		1		1	1		1		1	1		1		1
Spoons, dessert				5					5					5	
Stones, axe, hand				1					1					1	
Tools, Pulaski, with light sheath	1			1	1	1			1	1	1			1	1
Wedges, 2½ lb. felling			1					1					1		

Supervisors may make additions or adjustments to suit particular needs.

Fireman Pack:

The types of firemen's outfits set up as standard for this Region are listed below. The supervisor will designate that unit best adapted to meet the needs, and where necessary, make additions to or adjustments in units to meet the particular needs of a specific area. The addition of a mess kit is optional but not essential to the use of the present rations. The addition of a hand pump is also optional. Where finances

have not permitted the use of the headlight type of electric lamp, the Stonebridge lanterns, carbide lamps or palouser and candles may be substituted. The latter three are not stocked by the Procurement and Supply Division.

Fireman's Outfit No. 1:

1 pack frame and piece of canvas to cargo load.
1 pulaski tool with light sheath.
1 shovel with detachable handle.
1 file, 8-inch.
1 water bag, 2-gallon.
1 canteen, 1-quart or 1-gallon.
1 compass, pocket.
1 lamp, palouser and 3 candles or 1 electric headlight.
1 map, fireman's report, pencil and notebook.
1 small emergency medical kit.
Emergency rations as set up for the position.
(Approximate weight exclusive of water and rations, 19 pounds.)

Fireman's Outfit No. 2:

1 pack frame and piece of canvas to cargo load.
1 pulaski tool with light sheath.
1 saw, sectional, with scabbard and handles.
1 shovel with detachable handle.
1 file, 8-inch.
1 water bag, 2-gallon.
1 canteen, 1-quart or 1-gallon.
1 compass, pocket.
1 lamp, palouser and 3 candles or 1 electric headlight.
1 map, fireman's report, pencil and notebook.
1 small emergency medical kit.
Emergency rations as set up for the position.
(Approximate weight exclusive of water and rations, 25½ pounds.)

Fireman's Outfit No. 3:

1 pack frame and piece of canvas to cargo load.
1 axe, D. B., handles with clip sheath.
1 shovel, hazel-hoe combination, with handle.
1 file, 8-inch.
1 water bag, 2-gallon.
1 canteen, 1-quart or 1-gallon.
1 compass, pocket.
1 lamp, palouser and 3 candles or 1 electric headlight.
1 map, fireman's report, pencil and notebook.
1 small emergency medical kit.
Emergency rations as set up for the position.
(Approximate weight exclusive of water and rations, 22 pounds.)

Emergency Backpack Outfits. The outfits listed below are designed to be used by crewmen, emergency men and other employees who do not function in the same manner as regular firemen.

Crew or Emergency Fireman's Outfit, Desirable:

1 pack frame.
1 pulaski tool with light sheath.
1 shovel, with detachable handle, or ladies' shovel.
1 file, 8-inch.
1 water bag, 2-gallon or 1-gallon canteen.
1 lamp, palouser and 3 candles or carbide.
1 small emergency medical kit.
1 map.
Emergency rations as set up for the position.

(Approximate weight exclusive of water and rations, 17 pounds.)

Crew or Emergency Fireman's Outfit, Acceptable:

1 pack sack (may be homemade).
1 shovel, short handle.
1 axe, D. B., handled.
1 grubhoe, with handle.
1 lamp, palouser and 3 candles or carbide.
1 water bag, 2-gallon or 1-gallon canteen.
1 file, 8-inch.
1 map.
Emergency rations as set up for the position.

(Approximate weight exclusive of water and rations, 21 pounds.)

Plow Unit:

2 pads, saddle.
2 saddles, decker, large.
2 blankets, saddle.
1 bucket, water, canvas.
1 chain, log, light steel, tested with 2 hooks.
4 chains, butt.
1 clevis, with grab hook to fit chain.
12 links, open, cold-shut.
1 plow, complete No. 155 Oliver, or equal.
1 plow share, extra.
1 plow bolt set, extra, complete.
1 wrench, monkey, 8-inch.
1 wrench,, plow.
1 wrench, special bolt.
2 singletrees, heavy.
4 mantas, pack.
4 ropes, cargo.
2 bags, nose.
80 lbs. hay, baled.
50 lbs. oats.
1 pair handles, plow, extra.
1 bag, water, 2-gallon.
1 comb, curry.
1 brush, horse.

Supplemental Equipment Suggested:

2 bags, water, 5-gallon, M. P.
1 hammer, single-jack.
1 pair handles, plow, extra.
1 pair handles, saw, C. C.
1 kit, first-aid.
1 kit, veterinarian.
1 lantern, gas, with mantles.
1 outfit, horseshoeing.
1 peavy, light-weight.
1 saw, C. C., felling.
1 shovel, ladies'.
1 tool, pulaski, sheathed.
2 wedges, felling.

Loose Tool Outfit (10-Man):

Many fires on or adjacent to roads are handled by crews working out from the project camp. On such fires camp and mess equipment is usually unnecessary. When regular standard crew outfits are used on these fires serious loss and damage occur to the extra tools, lights, mess kits, sharpening outfits and other unused camp equipment. Use of standard crew outfits in such cases results in delay and extra work in breaking down and reassembling the more complicated and unused units.

To avoid this, a "loose tool outfit" has been designed which contains:

5 tools, pulaski.
1 saw, 5½, C. C.
2 handles, C. C.
5 shovels, lady.
1 hammer, S. J.
2 wedges, felling.
1 kit, first aid, packet.
2 files, 8-inch.

These outfits will be made up from forest-owned equipment, or through purchase from forest funds. They should be kept intact for fire use and will be kept with crews on the project. Number and distribution of these units will be in accordance with the approved equipment plan.

Power Pumpers:

The use of pumps on fires is encouraged, but forest officers in charge of fires must see to it that they are used only when a distinct advantage is gained by their use, that experienced nozzle men are provided and that the pump does not become a plaything. There is danger in tying up a large force of men in a pump crew to the detriment of extending control line around the fire.

Power pumps are rather delicate pieces of mechanism and easily get out of order. They shall be carefully tested at the end of the fire season, and any necessary repairs or adjustments made during winter, and must be checked before the beginning of the fire season. After transportation to a fire, each pump should be checked at distribution point before sending to the fire line. While power pumps are in actual operation, there should be someone in constant attendance to guard against accident to the machine, such as a clog in the cooling circuit or heating due to other cause. Hose shall be tested at the close of the season. The usual requirement is 1,500 feet of 1½ inch discharge hose with each power pump.

Complete instructions for the use of the power pump are packed in the box with the pump.

Mixed gas and oil held over winter shall never be used in pumper.

Pumper man upon emptying one-gallon can of mixed gasoline-oil fuel shall immediately mix another gallon, ½ to ¾ pint of oil per gallon of gasoline, for ready use. Never pour fuel into motor tank without first thoroughly shaking.

Keep chamois skin absolutely clean and always strain fuel through chamois skin into fuel tank. The Coleman felting funnel with special filtering fabric may be substituted. Be careful not to spill gasoline over pumper when filling.

Always empty pumper tank of remaining gasoline and rinse well with clean gas and drain carburetor. Also drain water out of pressure gauge pipe when there is any lengthy period of nonuse. Remove gas tank intake brass tubing in order to thoroughly drain tank. Do not spill gasoline on motor or magneto.

Before storing pumper away, pour oil into pumper intake opening and spin motor with spark off. This lubricates inside of pump.

In starting motor, brace foot against frame lug and do not press down on gasoline tank too hard when pulling starting cord. In stopping motor for short time, do so at stopping button and not at carburetor. If shut off at carburetor, starting again will be difficult. Do not tamper with carburetor unnecessarily after adjustment. See that pumper is properly lubricated for starting, then pour a few drops of oil on shafts every ten to fifteen minutes while running.

See that cooling system is functioning, make certain that water flows from all four motor-head drain pipes. If water fails to drain from one drain pipe, it may be forced through it by placing your fingers over the others. If this fails, stop motor immediately and clean pipe line. Do not run water-cooled motor without water passing through it. Drain water away from motor and make certain it does not splash up motor. Do not use muddy water or allow drains from motor to foul the water supply.

If pumper suction fails, pour water into intake hose, raise above motor, then spin motor a few times with spark off. Then place intake in water. Protect intake suction from mud or sand by placing it in a bucket, on a flat stone by suspending it from a pole laid across pool, or by placing on weighted-down canvas.

Use hose wrench for tightening connections at pump only. With hose gaskets in place, hand-tightening for the hose line is sufficient. Do not kink hose for any reason whatsoever. Use Siamese pump outlet at pump so pressure may be cut off from motor for easier starting.

When pumper is shut down temporarily, retain water in delivery pipe by shutting off valve at pumper outlet. *Be sure to open this valve before starting pumper again.*

The delicate mechanical parts of the motor must not be tampered with by anyone except an experienced pump mechanic.

Directions for starting Pacific motor are to be found on top of gasoline tank. A record of hours run must be kept by the operator. In order to facilitate setting up of pumper, tool kit may be packed with pumper in engine box.

Pumper operator must be with running pump continuously to see to proper lubrication and stop and start pump at signal from hose men.

Do not permit smoking or open flame near pumper or gasoline containers. Always use electric flashlights for close lighting. If other lights are used, keep at safe distance.

Place main gasoline supply several feet away from pumper to avoid unnecessary danger. Some pumper tanks have an air cut-off valve at gasoline intake. Be sure this is opened for running.

Pacific Pump Accessory List:

10 bundles hose, containing:
 30 pieces, 50 feet, 1½ inch hose, or 1,500 feet in all.
1 box, weight about 106 pounds, containing:
 1 Pacific pumper.
 1 instruction book for pumper operator.
 1 contact screws and points, catalog No. UF-11.
 1 breaker blades and points, catalog No. UF-10.
 1 magneto wrench and gauge, catalog No. UF-537.
 1 magneto file for breaker points and spark plugs.
 1 pump record and test card.
 1 instruction card for testing pump.
 1 pencil and forest instructions.
1 box, accessory, weight about 100 pounds, containing:
 1 packing nut wrench.
 2 nozzles with 2 extra nipples ¼ inch and ⅜ inch holes.
 3 Siamese couplings, with valves.
 1 suction hose with strainer.
 1 copper screen for suction hose strainer.
 1 chamois—to strain gasoline. *Keep clean.*
 1 1-quart measure.
 1 ½-pint measure.
 1 funnel, tin, medium-sized.
 2 frames, pack.
 1 pack cover, 6 x 7.
 1 yard cleaning cloth.
 20 hose gaskets.
 4 spanner wrenches for hose.
 1 pair auto pliers.
 1 wrench, crescent, 6 inch.
 1 screwdriver, 6 inch.
 2 starter ropes.
 2 extra spark plugs.
 1 lb. cup grease (soft).
 ½ gallon lubricating oil (Quaker State, medium).
 1 wrench, Stillson, 10 inch.
 1 coil stovepipe wire.
 ¼ bar Fels-Naptha soap for gas line connections.
 1 flashlight, 2-cell, with 2 cells and 1 bulb extra.
 1 ball marlin rope, ¼ inch, for tying hose.
 3 feet friction tape, for ignition wires.
 1 copy of this list.

Note: Use 1 Siamese on pump outlet, other in hose line.

1 box, containing:

6 buckets, canvas, water } Put in another box if feasible.
4 tin cups or tomato cans }

1 box, containing:

10 gallons standard grade gasoline unmixed. Hereafter do not mix this supply of gasoline except as needed on the job. Do not use Ethyl gasoline.

1 box, containing:

1 gallon of standard grade gasoline with ½ pint of Mobile A No. 30 or Conoco Germ-Processed No. 30 oil thoroughly mixed.

1 gallon of Mobile A No. 30, Conoco Germ-Processed No. 30 or other brand oil approved by the fire office.

1 package containing:

2 shovels.
1 peavy, light-weight.
1 pulaski and sheath.

Report on Use. A record of use for each pumper is required. These records will provide a history of each machine and will eventually determine the value of the various types in use. This record will establish a systematic plan for inspection and reconditioning of these costly implements.

A form indicating identification and running time of each pumper will be kept with the machine. This record will be filled out each time the pumper is operated. When the running time totals 100 to 120 hours the pumper will be due for complete mechanical inspection and will be shipped to the Spokane warehouse for such service. The record of operation will accompany the pumper. After reconditioning the pumper, the repair shop will replace the old operation record with a new form on which will be recorded the date of repair, the machine inspector's signature and an entry of zero in the column for running time. Thus a new record of service will be started.

USE AND CARE OF LIGHT

Listed below in their respective order of preference are the various kinds of lights now in use by fire control forces. As rapidly as possible the less desirable types are being replaced by the more satisfactory electric flashlight type:

1. Electric flashlight (headset type).
2. Palouser (can and candle).
3. Stonebridge lantern (candle type).
4. Carbide lamp (miners').
5. Mantle lanterns, gasoline (for camp use only except in special cases).

Electric Flashlight:

1. Keep extra set of batteries available.
2. Keep extra bulb in bulb clamp in rear cap.
3. Prevent accidental battery drain by fastening a piece of stiff cardboard over contact button with a piece of adhesive tape or by removing batteries when storing light in pack or tool cache. Cardboard placed between batteries will also prevent accidental drain.
4. Keep connection nuts tight on headset. Roughen threads or swadge slightly to prevent loss of nuts.
5. *Never leave* batteries in case over winter.

Palouser:

1. Carry extra candles (plumbers'). Use a wire bail for convenience in carrying.
2. Be careful that shortened candles do not drop out and start a fire.

Stonebridge Lanterns:

1. Carry extra candles (plumbers').
2. To clean mica windows clean in very hot soda water or use kerosene and rag.

Carbide Lamps:

1. Fill lamp bottom 2/3 full of carbide.
2. Use miners' size carbide (¼ inch).
3. Set valve lever on notch marked "off."
4. Open cap on top of lamp and fill water container full of water.
5. Screw bottom on tightly. Turn water on slowly by turning lever to left two or three notches and permit the air in the lamp to escape through the tip for a few seconds; then light with the lighter attached to the reflector.
6. To light, cover the reflector with palm of hand, hold a few seconds, then draw the hand downward quickly. Rubbing the hand over the wheel makes a spark which lights the gas. If hand is held too long, a loud report is produced but does no harm.
7. When lamp has been lighted, regulate flame by turning lever which controls the flow of water into the carbide one or two notches at a time. Do not flood your carbide as your lamp will not burn properly.
8. Keep the lamp clean when not in use.
9. Use new felt when the old one becomes hard.
10. Clean tip with special No. 37 tip cleaner or with a strand of emergency wire when necessary.
11. When through using the lamp, do not let the flame burn out—this clogs the tip with carbon.
12. When the flame begins to die down after water has been turned off, blow it out.

Mantle Lanterns:

1. Always use transparent mantle protector globe and metal lamp top provided with each light.
2. Preheat generator tube thoroughly before turning on gas.
3. Never fill gas reservoir over 2/3 full with gasoline as air space must be left.
4. Never open refill cap with lamp lighted, in a closed room with an open flame therein or near an open flame anywhere.
5. Replace broken mantles as soon as possible.
6. Clean generator rips only with special cleaner provided or with a fine emergency wire strand.
7. Extra generators, mantles and gasoline should be kept available.
8. *Do not* use colored gasoline of any kind as it will soon plug generators. Hi-test or aviation gasoline is best suited.
9. Never try to light a lamp or lantern upon which new mantles have been placed until the wax has been completely burned off.

TORCHES

Whatever method is used in controlling a fire, a certain amount of burning out may have to be done. Torches are faster and more effective than firing by hand and are provided as a means of speeding up the work.

The Propane Torch:

Propane is a liquefied gas which is highly inflammable when released from pressure.

The propane torch unit comprises a heavy cylinder and a burner connected by hose and tubing. The cylinder is fitted with a valve and the tube above the burner with an operating valve. The cylinder or tank is strapped to a pack frame for back-packing. To use the torch, the valve on the cylinder is first opened and then the gas is released into the burner by opening the operating valve. The torch must be ignited at the extreme end of the burner. It cannot be ignited through the holes in the sides. Full instructions are packed in the box with the torch.

To use the instructions intelligently, forest officers must remember that propane, under pressure in the tanks, is a liquid and does not become a gas until released. When released, it is highly inflammable at temperatures above 40 degrees F.

In filling the torch cylinder the supply tank must be elevated to allow the liquid to flow downward. The pressure in the torch cylinder must be reduced by cooling, and that in the supply tank raised by warming. The supply tank may be kept in the sun and the torch cylinder cooled in a stream.

Propane gas will blister the skin and care should be used in handling the pigtail connection after closing the valves in both tanks on account of the gas remaining in it.

100-RATION LIST

(Subsistence Supplies for 100 Men for One Day)

Flour:

White, 3/25-lb. or....................2/3 bale
Bread, 1-lb. loaves 100

Leavening:

Baking powder ....3 lbs.

Cereals:

Rolled oats, 9 lbs.........................1 sack
Rice, 3 lbs...................................2 sacks

Meat and Lard:

Ham, 12-14 lbs...........................40 lbs.
Bacon, 8-10 lbs..........................15 lbs.
Roast beef, 24/2........................¼ case (6 cans)
Shortening, 2 lbs. ....2 pails

Dairy Products·

Butter, 2 lbs.................................6 tins
Milk, tall (48)............................1 case
Cheese, 1 lb...............................10 cart.
Eggs, fresh—30 doz...................1 case

Beverages:

Coffee, 1 lb.................................10 cans
Tea, black, ¼ lb.........................1 pkg.
Orangeade base—8 oz............16 cans
Lemon concentrate—8 oz.......8 cans

Sugar:

Sugar, 20/5 ....¼ bale (5 sks.)

Vegetables:

Beans, lima, 10 lbs.....................1 sack
Beans, navy, 10 lbs....................1 sack
Onions ....12 lbs.
Potatoes ....50 lbs.
Macaroni, 24/1-lb.....................⅛ case (3 pkgs.)

Vegetables, Canned:

Corn, 24/2's ....⅜ case (9 cans)
Carrots, 24/2½.......½ case (12 cans)
Pork&beans, 72/8 ⅓ case (24 cans)
Sauerkraut, 24/2½ ¼ case (6 cans)
Tomatoes, 24/2½..½ case (12 cans)
Sweetspuds, 24/2½ ½ case (12 cans)

Canned Fruit:

Fruit in 8-oz. cans for lunches, 72/8..................2 cases

Jam:

Strawberry, 24/14-⅙ case ......6 cans
Pine-cot, 24/1-⅙ case ....6 cans

Dried Fruit:

- Apricots, 5 lbs. ..... 1 can
- Prunes, 5 lbs. ..... 2 cans
- Raisins, 1 lb. ..... 3 cart.

Relishes, Extracts, Spices:

- Pickles, dill, No. 2½ can ..... 5 cans
- Pepper, black, 4 oz. ..... 1 can
- Salt, 3 lbs. ..... 2 sks.

Soaps, Etc.:

- Soap, laundry ..... 12 bars
- Soap, toilet ..... 12 bars

Miscellaneous:

- Matches, 20 cartons ..... 3/20 cs.
- Candles (6) ..... 3 sets (18)

Order Bread Separately.

200-RATION LIST

(Follow-up)

Flour:

- White, 3/25 lbs. or ..... 1 bale
- Bread, 1 lb. loaves 200

Leavening:

- Baking powder ..... 3 lbs.
- Soda ..... 1 lb.

Cereals:

- Rolled oats, 9 lbs. ..... 2 sks.
- Rice, 3 lbs. ..... 4 sks.

Meat and Lard:

- Ham, 12-14 lbs. ..... 80 lbs.
- Bacon, 8-10 lbs. ..... 30 lbs.
- Roast beef, 24/2 ..... ½ case (12 cans)
- Shortening, 2 lbs. ..... 4 pails

Dairy Products:

- Butter, 2 lbs. ..... 12 tins
- Milk, tall (48) ..... 2 cases
- Cheese, 1 lb. ..... 30 cartons
- Eggs, fresh—30 doz. ..... 2 cases

Beverages:

- Coffee, 1 lb. ..... 20 cans
- Tea, black, ¼ lb. ..... 2 pkgs.
- Orangeade base—8 oz. ..... 32 cans
- Lemon concentrate—8 oz. ..... 16 cans

Sugar:

- Sugar, 20/5 ..... ½ bale (10 sks.)

Vegetables:

- Beans, lima, 10 lbs. ..... 2 sacks
- Beans, navy, 10 lbs. ..... 2 sacks
- Onions ..... 24 lbs.
- Potatoes ..... 100 lbs.
- Macaroni, 24/1-lb. ..... ¼ case (6 pkgs.)

Vegetables, Canned:

- Corn, 24/2's ..... ½ case (12 cans)
- Carrots, 24/2½ ..... 1 case (24 cans)
- Pork & beans, 72/8 .. 1 case (72 cans)
- Sauerkraut, 24/2½ ½ case (12 cans)
- Tomatoes, 24/2½ .. 1 case (24 cans)
- Sweet spuds, 24/2½ 1 case (24 cans)

Canned Fruit:

- Fruit in 8-oz. cans for lunches, 72/8 ..... 4 cases

Jam:

- Strawberry, 24/20—½ case .. 12 cans
- Apricot, 24/20—½ case ..... 12 cans

Dried Fruit:

- Apricots, 5 lbs. ..... 2 cans
- Prunes, 5 lbs. ..... 4 cans
- Raisins, 1 lb. ..... 8 cart.

Relishes, Extracts, Spices:

- Pickles, dill, No. 2½ can ..... 10 cans
- Pepper, black, 4 oz. ..... 1 can
- Salt, 3 lbs. ..... 2 sks.

Soaps, Etc.:

- Soap, laundry ..... 20 bars
- Soap, toilet ..... 20 bars

Miscellaneous:

- Matches, 20 cartons ..... ¼ case
- Candles (6) ..... 4 sets (24)

Order Bread Separately.

SHARPENING TOOLS

CROSSCUT SAWS

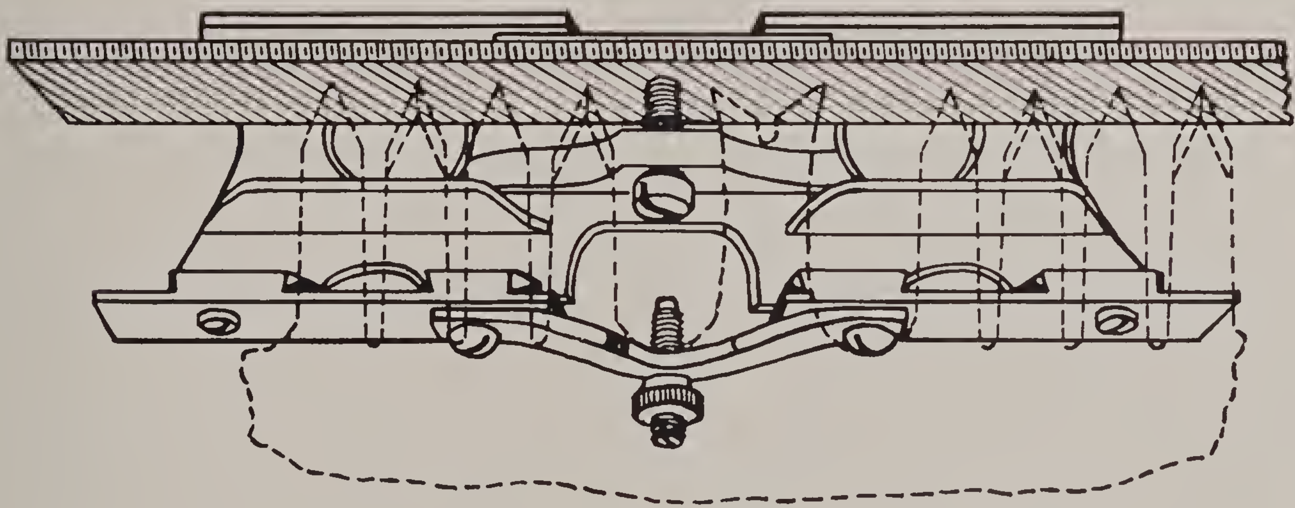
Setting or sharpening crosscut saws is a job for an expert, but in some isolated regions experienced filers are not available. Saws must, however, be kept in good repair. With this in mind, all material in this topic has been compiled as an aid to the beginner for whatsoever value it may be to him.

Crosscut saw teeth must be filed or fitted to suit the kind of timber to be cut. Shorter rakers (drags) and a flatter bevel on the teeth and a greater set is needed to cut soft wood than hard wood, or dry wood. More set is also needed to cut pitchy wood than nonresinous species.

To properly fit or file a crosscut saw, the operations in the order listed are necessary. Each one is very important and calls for application of particular pains upon the part of the filer.

First .... Jointing teeth
Second .... Dressing the rakers
Third .... Filing
Fourth .... Setting

JOINTING



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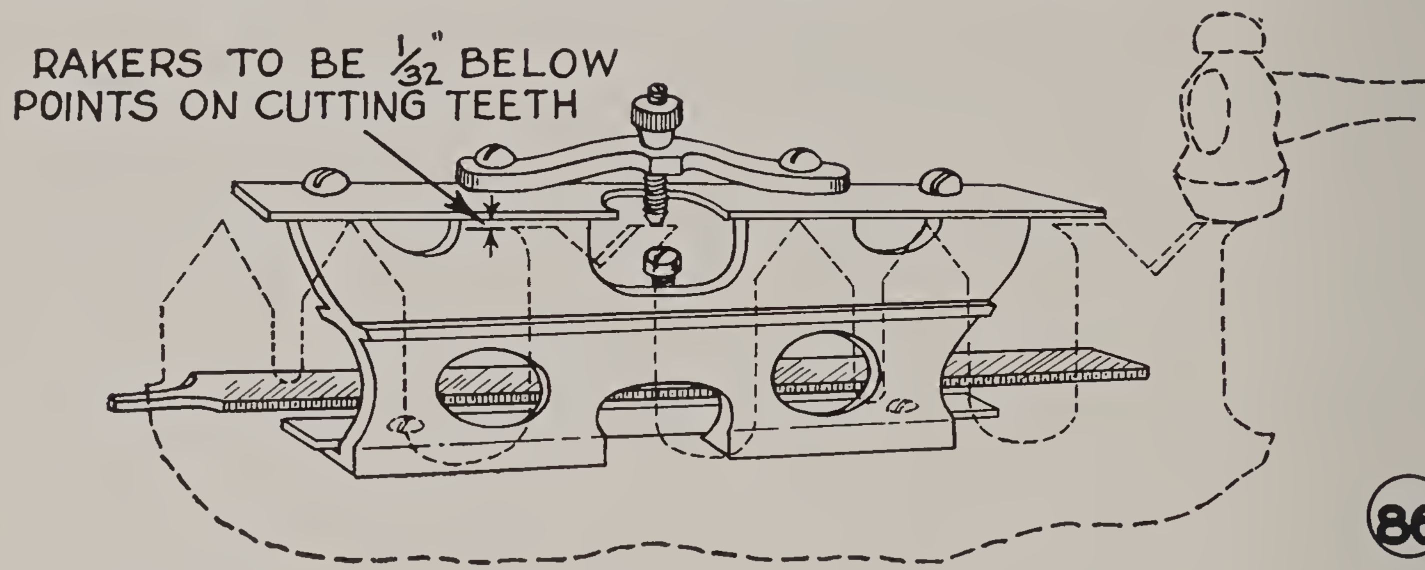
Jointing means to make all teeth the same length. To accomplish this, place a seven or eight inch standard bastard mill file edgeways in any universal saw tool and secure it by the thumbscrews. Place tools as shown in Figure 85 and pass the file lightly over the teeth. This will take off the high spots. Watch closely until every tooth shows that the file has touched it. Then stop. Use care to prevent any unnecessary use of the file. To have every tooth show a file mark is the object. The longer teeth will show a heavy mark, while shorter ones should show a mere trace of the file's work.

DRESSING THE RAKERS

Two styles of rakers are commonly used, i.e., the swaged raker and the straight raker. Swaging rakers calls for greater skill than can be expected from an inexperienced man, and since this section is prepared as a guide to inexperienced forest officers, the simpler method will be described. Many of the most expert filers use it in preference to swaging. Unskilled men working without instructors had better not try the swaging method.

Rakers should be 1/64 to 1/40 of an inch shorter than the cutting teeth for sawing drier hardwood; 1/40 to 1/32 of an inch for softwood. The various combination crosscut saw tools have different contrivances for adjusting the raker gauge to different heights in order to secure the differences of length mentioned.



86

To dress rakers, place the gauge in such position on the body of the tool that the raker teeth will project through the slot in the gauge the desired amount and then file the points even with the hardened surface of the slide. This operation is called jointing the rakers. The raker teeth can be made longer or shorter by moving the slide one way or another. When the raker teeth project through the proper amount (1/64 inch to 1/40 inch for hardwood; 1/40 inch to 1/32 inch for softwood), fasten the slide in position by tightening the screws.

After the rakers have been jointed, to check the length, place the gauge on the saw over the raker and file down flush with the steel face.

After jointing the rakers, next take off the wire edge caused by jointing. Do this by a stroke with the file on the straight side of the raker. Next, file the gullet of the raker from the bottom out to the point, so the heel of a square will fit in the raker gullets. Always make both raker points square across and even in height. The cutting teeth really act as markers and the rakers are in reality chisels which follow along and plow out the space between the two lines marked. Therefore, the chief thing in saw fitting is to have the rakers right.

FILING

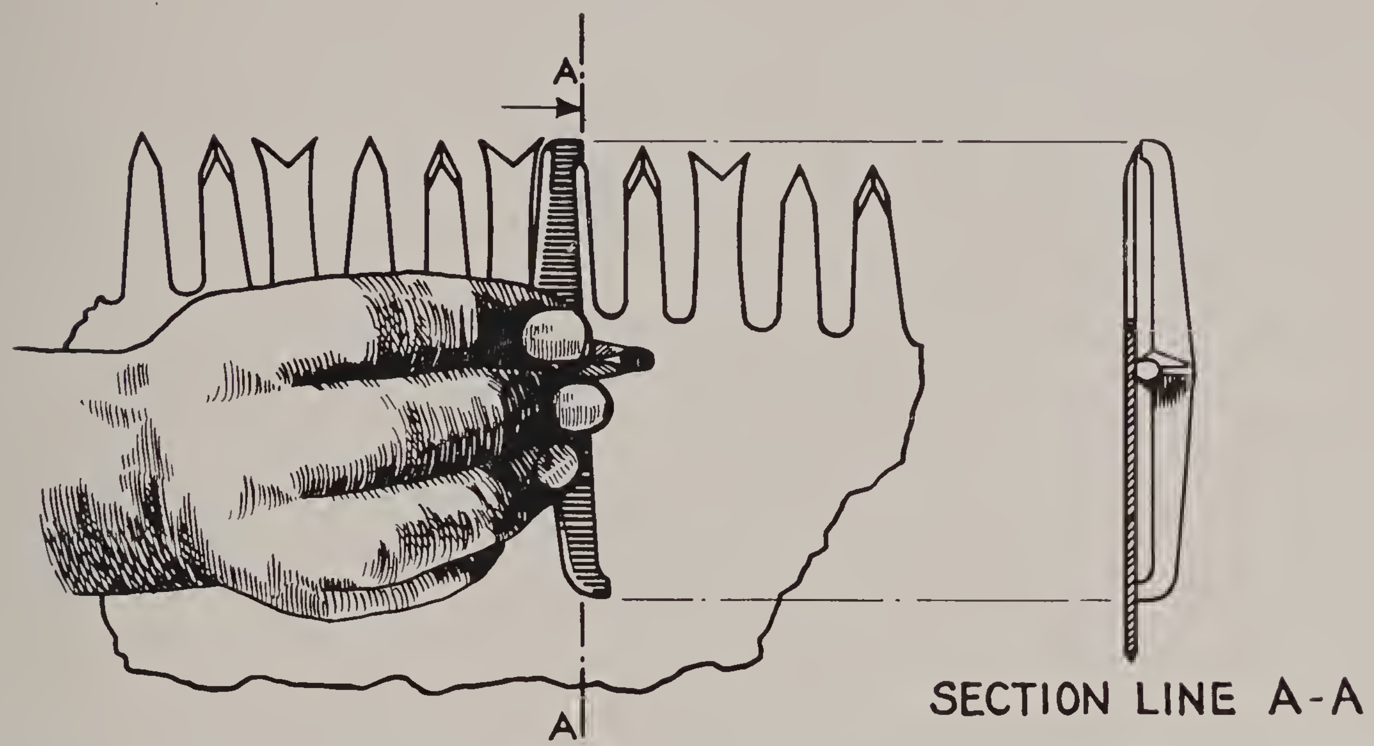
When filing, bring each tooth to a keen cutting edge, taking care not to reduce the length of the tooth any more than is necessary to remove the marks of jointing work, then with the file in a nearly vertical position and resting evenly on the bevel, file with a precise upward stroke. This gives a keen, strong point.

Don't drag the file back on the tooth; lift it up; bastard files cut only on the out stroke. For cutting hardwood, teeth require a more abrupt bevel than to cut softwood.

SETTING

If the saw requires setting, lay the block or anvil on a stump, log or block; fasten in position by striking it with a hammer over the wedge which forms a part of the bottom on the anvil, until the anvil is firmly in position. The body of the saw is then laid as shown in sketch. Extend the point of each tooth over the shoulder about one-quarter inch, as pictured, then give two or three blows with a light hammer. Strike the tooth always about one-quarter inch from point. It is very important that the "set" should be perfectly uniform, that is, exactly the same amount of set to all teeth. This can be tested by the use of set gauge. The amount of set required is

largely determined by the kind of timber to be cut and the manner in which the saw is ground. For softwood it should be about 1/40 inch (or equal to about one or two thicknesses of ordinary writing paper) on each side of the blade. If wood to be cut is pitchy or spongy, it may be necessary to increase the amount of set to 1/32 inch on each side of the saw.



87

To test the set, place the gauge as shown in sketch.

If the allowance for set on the gauge is not what is wanted, this can be quickly made anything desired by filing one or the other of the working points.

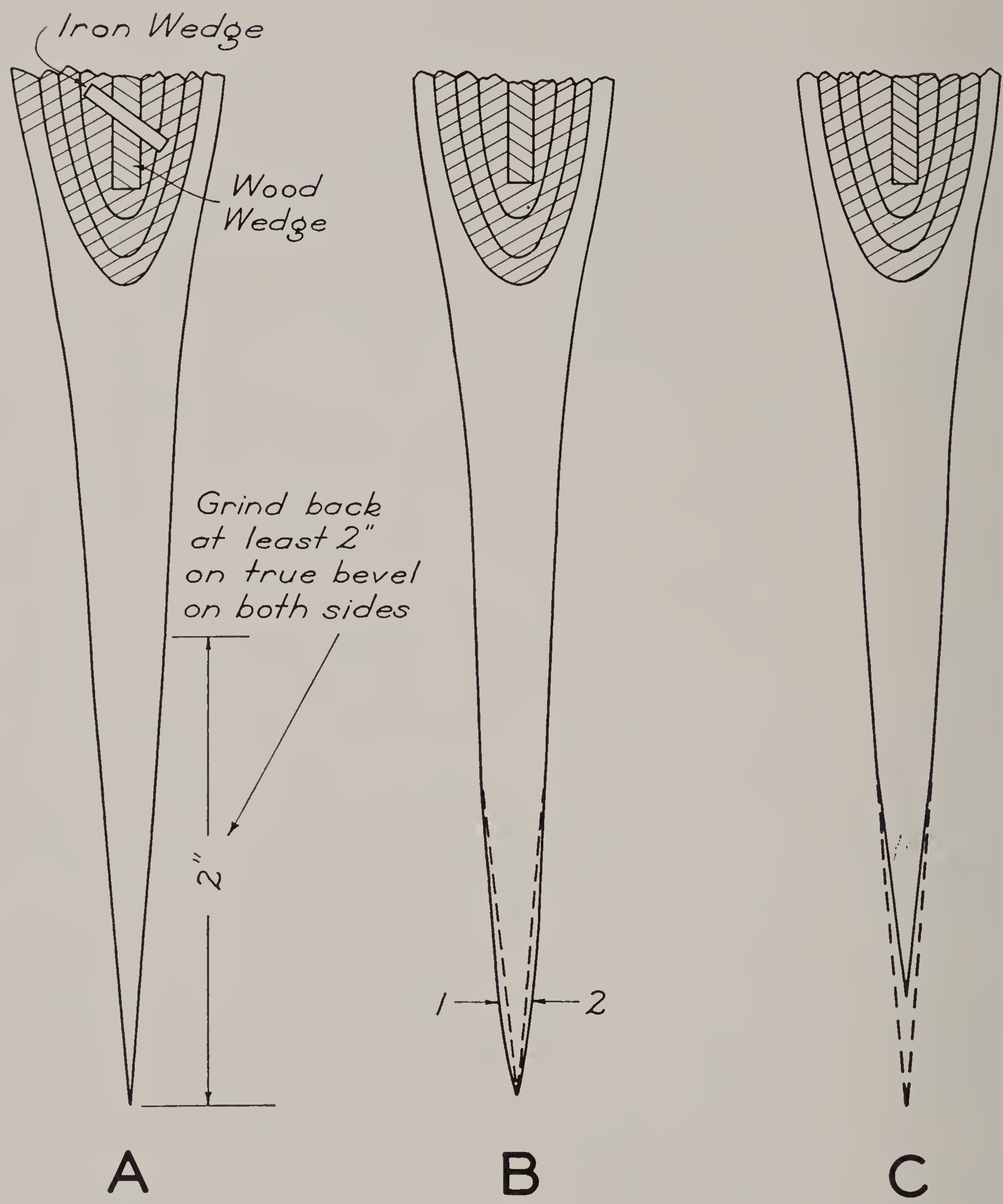
Caution:

The teeth must be kept even and points must be sharp and smooth. A rough edge point will break off in hard grain or knots just as surely as a freshly-ground axe will crumble or nick if used without whetting. Rakers must be shorter than the cutting teeth so as to plow out all the wood cut by the cutting teeth.

AXES AND PULASKIS

Sharpen as shown on chart. Avoid grinding closer than ¼ inch from edge with coarse stone. This draws temper. Finish edge with five grain stone. Keep in sheath after sharpening. Safety to man and tool. Tighten handles. Drive wedge in eye. New wedge if necessary. Test handles in all outfits once each month. Weekly in fireman packs. Don't lean on handles, and don't put pressure sidewise against handles in storing—crooks them.

PRINCIPLES TO BE OBSERVED IN SHARPENING AXES



A - Well ground axe indicating proper taper to cutting edge.
B - Improperly ground axe. Shoulders at (1) and (2) should be reduced so axe appears as indicated by dotted lines.
C - Frequent grinding will shorten blade but proper cutting edge should be preserved as indicated

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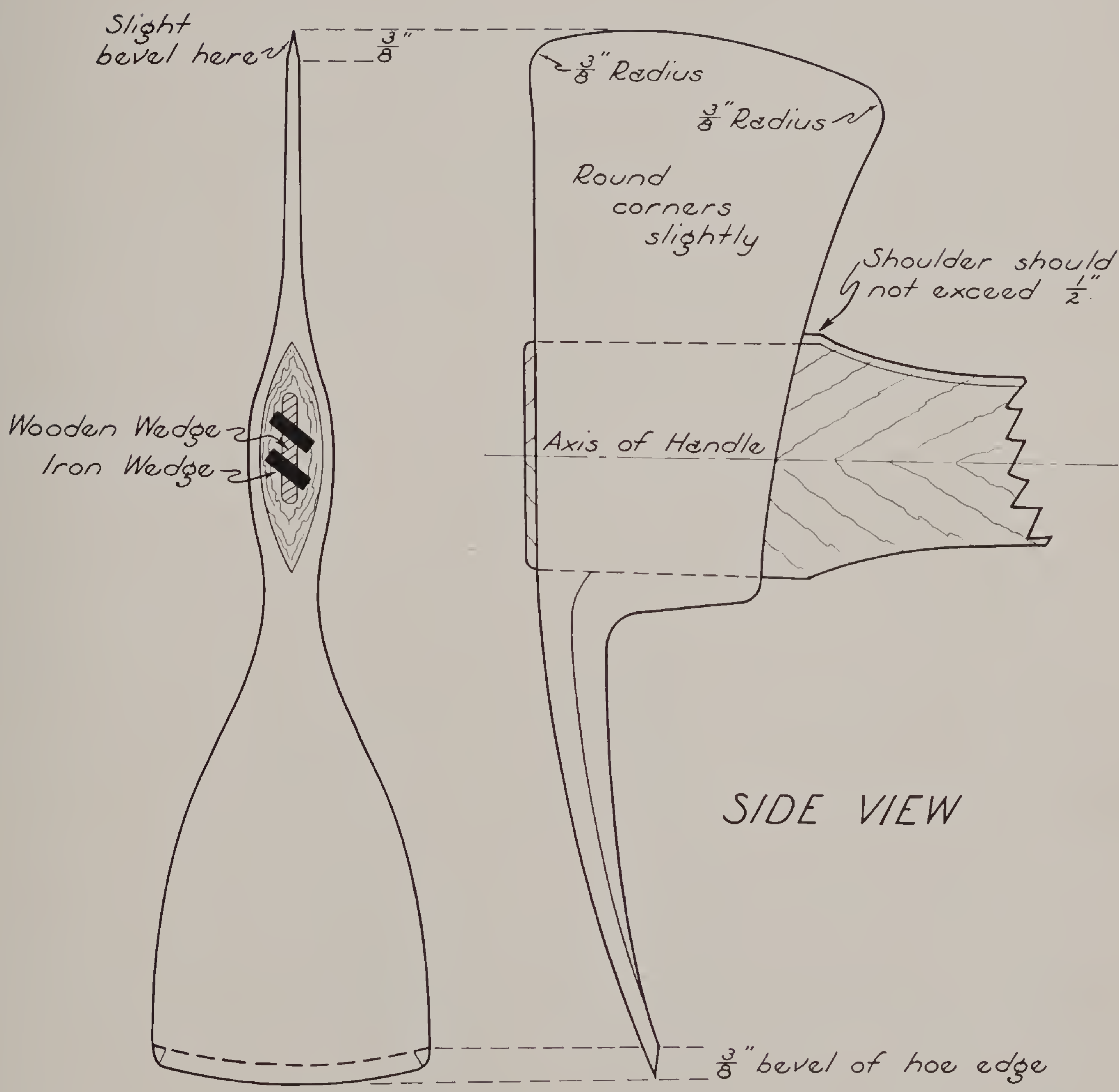
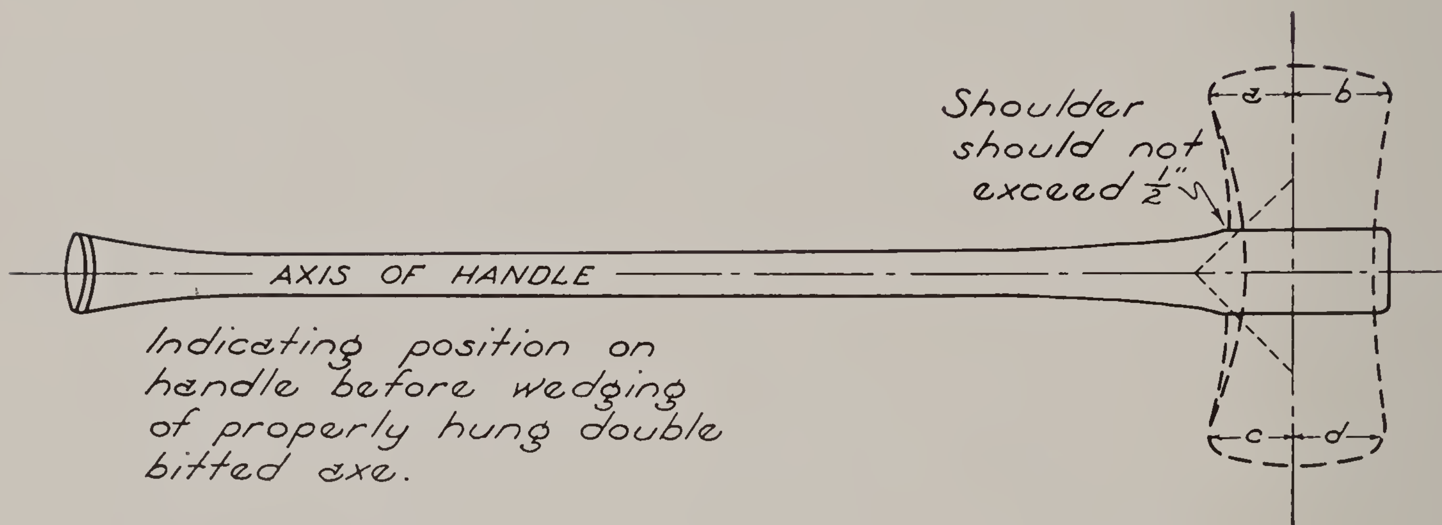
REHANDLING PULASKI TOOL



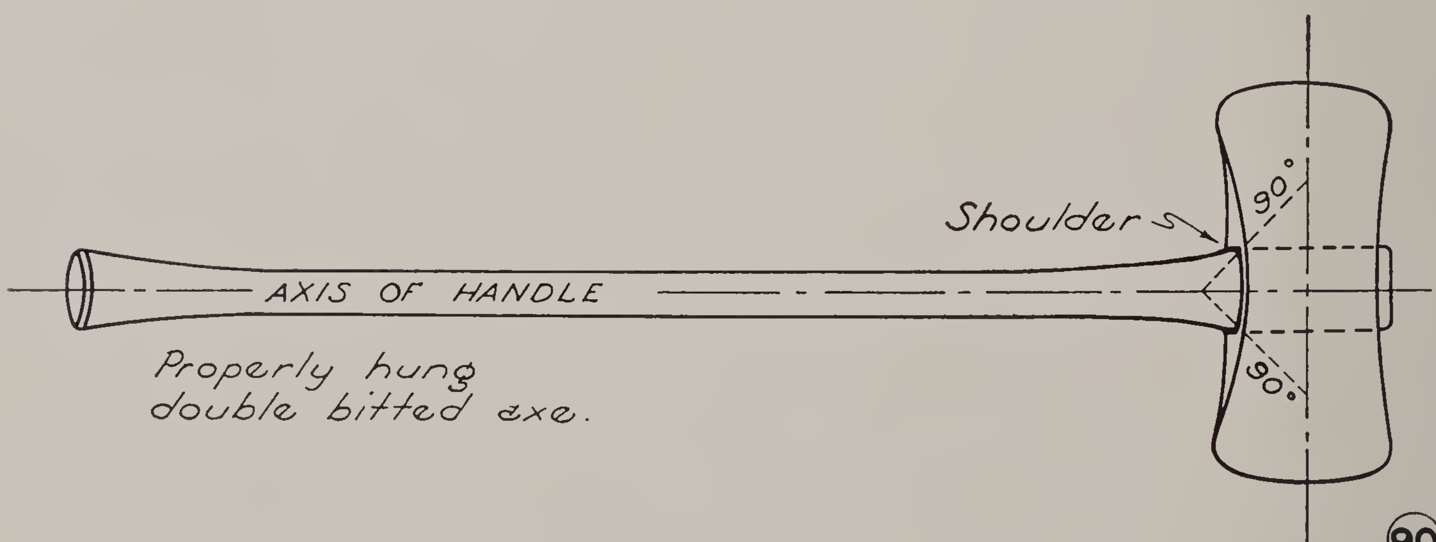
Well ground Pulaski indicating proper taper cutting edge.

(89)

PRINCIPLES TO BE OBSERVED IN HANDLING AXES



Indicating position on handle before wedging of properly hung double bitted axe.



Properly hung double bitted axe.

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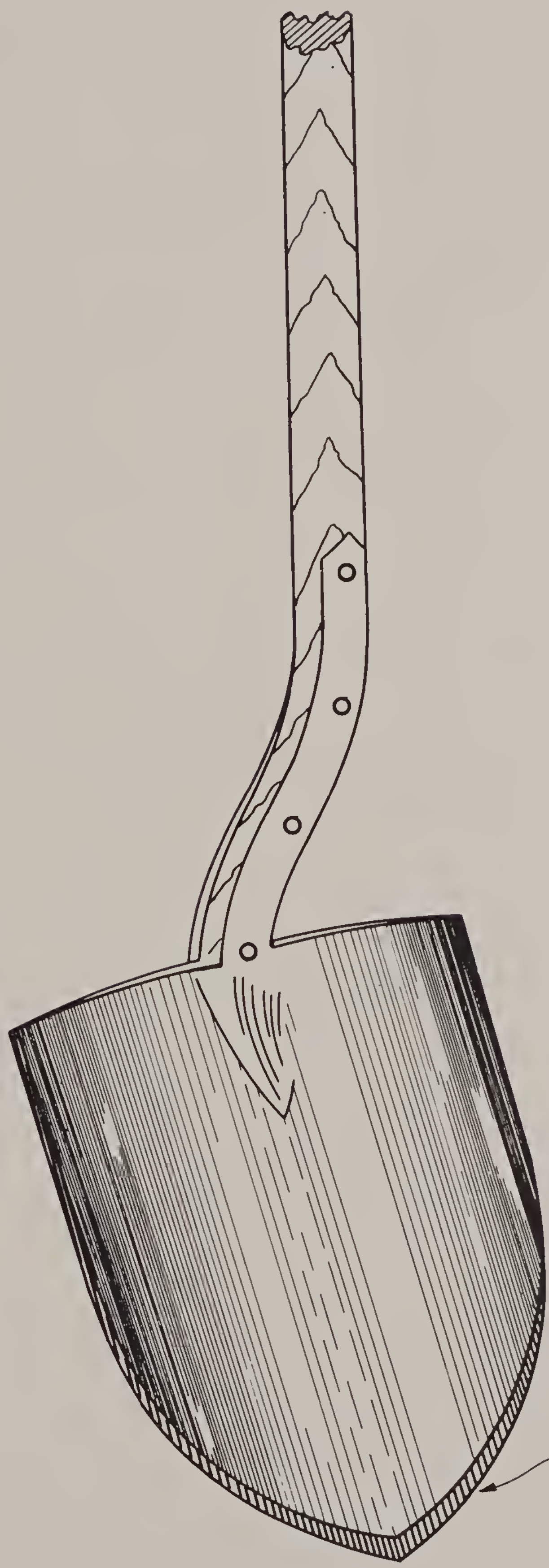
Sharpen as indicated on chart. Wrap or sheath for packing. Oil or grease to prevent rust.

GRINDING SHOVEL



Well ground shovel indicating proper taper to digging edge.

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COMMUNICATION

TELEPHONE

INSTALLATION

1. Fasten up with screws.
2. Check batteries; must be initialed and dated when installed.
3. Don't replace a single battery; put in an entire new set. If new ones are not available use only the good ones until replacement can be made. Destroy all useless batteries. Save weakened batteries for mapboard lights.
4. Check wiring of batteries; tighten connections.
5. Check all phone connections; must be clean and tight. Old connections often work loose or corrode.
6. Main and ground wire connections must be soldered or clamped.
7. All wiring properly insulated.
8. Place protectors so printing is right end up.
9. Drive ground rod full length in moist earth, as nearly direct under protector as possible.
10. Up-to-date call card posted at telephone.
11. Clean contacts on knife switches with cloth.

TROUBLE SHOOTING

Various troubles are listed below with possible causes of the trouble in each case.

Telephone Bell Does Not Ring or Rings Faintly When Others Call:

1. Defective ringer—either open or out of adjustment.
2. Broken wire or loose connection in telephone set.
3. Short circuit in your telephone or some other telephone on the line.
4. Receiver off the hook at some telephone where there is no condenser in the receiving circuit.
5. A low resistance ringer connected somewhere on the line.
6. Open fuse at the arrester on the outside of the building.
7. Short circuit in lightning protection. Disconnect protection from rest of circuit or pull out protector tube.
8. Broken line wire or service wire.
9. Line wire grounded by touching trees, brush or ground, if grounded circuit.
10. Over-loaded line; too many telephone instruments on the line.

Bell Rings Frequently Without Apparent Cause:

1. Line crossed with other telephone line.

All Bells at a Switching Station Ring When Only One Line Is Called, Even When Switches Are Open and No Cross Exists Between the Lines:

1. Poor ground connection. Separate ground rods farther apart or saturate ground around rods.
2. Too high resistance of wire leading from ground, due to wire being too small.

You Cannot Ring Bells of Other Telephones:

1. Defective ringer at telephone being called.
2. Defective generator—either at your telephone or at the telephone being called.
3. Broken wire or loose connection in telephone set.
4. Open fuse; replace or short circuit with a wire across fuse connection.
5. Short-circuited line, if metallic circuit.

6. Line wire grounded by touching trees, brush or ground, if grounded circuit.
7. Low resistance ringer connected somewhere on the line.
8. Broken line wire or service wire.
9. Poor ground connection.
10. Short circuited protector blocks. Disconnect protection from rest of circuit or pull out protector tube.
11. Overloaded line—too many telephone instruments on the line.

You Cannot Make Others Hear You Talk:

1. Batteries weak or improperly connected.
2. Switch hook out of adjustment or contacts poor.
3. Loose or defective connections to transmitter.
4. Poor connections on receiver circuit of telephone being called.
5. Open induction coil on either telephone.
6. Transmitter is packed. Rap sharply with knuckles on side of transmitter.

You Cannot Hear Others Talk:

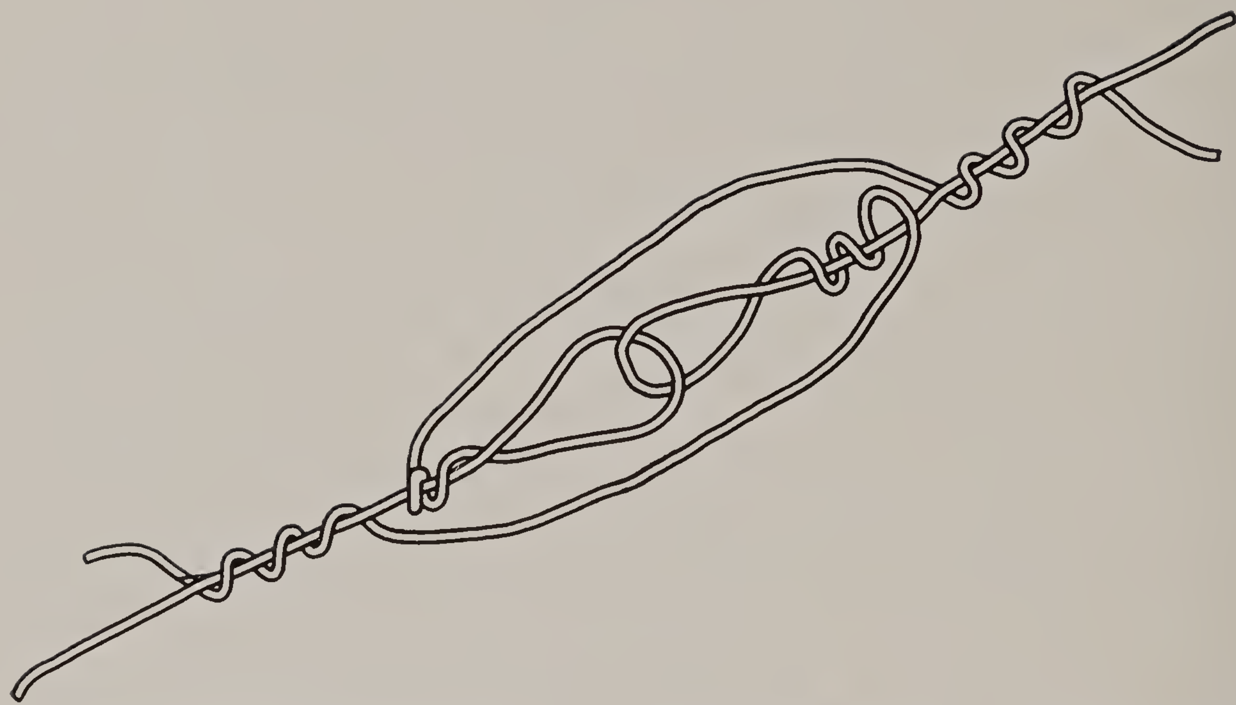
1. Receiver or receiver cord is open. Connect one end of receiver cord to a battery and click should be heard when other end is touched to opposite battery post, if O. K.
2. Defective or dirty receiver; remove cap, clean and tighten connections.
3. Loose or broken connections in telephone.
4. Switch hook out of adjustment or contacts dirty.
5. Open induction coil.
6. Defective transmitting circuit on other telephone.

Your Conversation Is Interrupted So That You Only Hear Parts of Conversation:

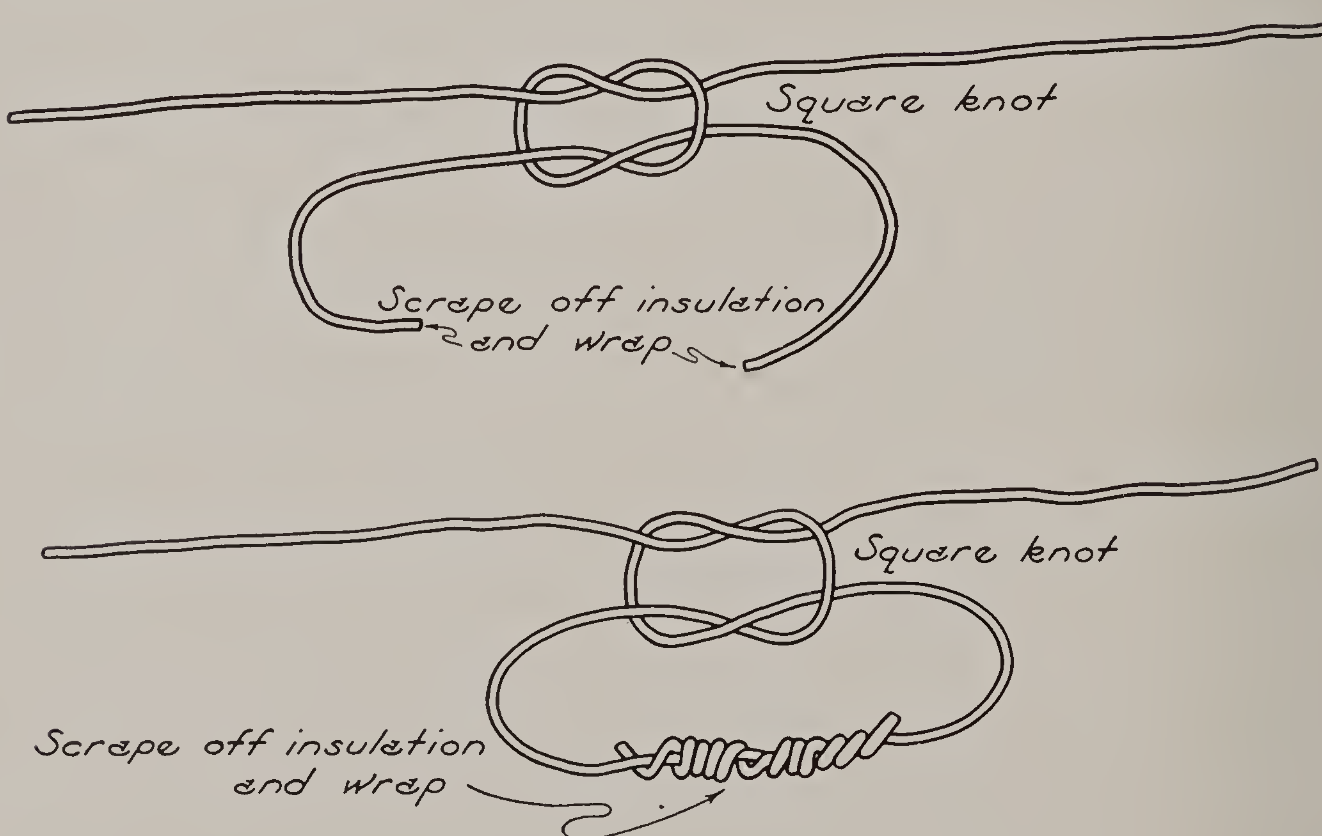
1. Loose connections somewhere on line. Check line wire and ground wire connections.
2. Poor ground wire, if grounded circuit.
3. Swinging cross on line wires or grounded intermittently.
4. Line wire swinging against lightning rod on poles.
5. Loose splice in line wire.
6. Line crossed with other telephone line.
7. Defective receiving circuit.

LINE MAINTENANCE

1. Don't pull up a tree line too tight when making repairs.
2. Rehang line at same height as original construction, 15 or 18 feet above ground.
3. Remove brush and limbs that touch the line.
4. Keep spans even and wire free of all contacts.
5. Replace broken insulators.
6. New poles set must not be less than 5 inch top diameters.
7. Check poles and guy wire to make sure they are substantial.
8. Remove poor splices from line. Old splices frequently work loose and cause a high resistance.
9. Don't make permanent connections between lines or change phones from one line to another without approval of district ranger.



EMERGENCY MAINLINE SPLICE
IRON WIRE



STANDARD SPLICE FOR EMERGENCY
WIRE

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TELEPHONE DON'TS

1. Check wiring in the telephone set but don't attempt to take it apart internally.
2. Don't attempt to adjust ringer.
3. Don't oil any part of a telephone except as directed by ranger.
4. Don't blame your set the first time; try again. Other party may not be on line.
5. Don't neglect to pour water around your ground rod frequently.
6. Don't experiment with the instrument.
7. Don't leave receiver off the hook; this runs down the batteries.
8. Don't touch the telephone line during lightning storms.

TELEPHONE DO'S

1. Be courteous.
2. Listen in before ringing.
3. Rubbering interfers with service; it is prohibited.
4. Do not use unnecessarily.
5. Answer your ring promptly; keep within hearing of phone, unless released by ranger.
6. Report promptly on time.
7. If unable to ring headquarters, report to your neighbor and have him try for you.
8. Be sure drop phones are disconnected before leaving.

RADIO

TROUBLE SHOOTING

Read the Instruction Manual thoroughly. Trouble is generally outside of the set, so begin checking here. Do not go inside of the set without permission from the forest officer in charge, and then only after satisfying yourself that the trouble *is not outside*. In case of trouble, check the set according to the following outline:

Battery Trouble:

1. Check voltage of all batteries according to instructions in manual. Report to the ranger when batteries are low and ask for replacements in time enough so that they will arrive before old batteries are entirely run down.
   (a) Testing A batteries:
   Place set in operation by placing the "Recv-Trans." switch in "Trans." position. Turn meter switch to "Trans. Fil" position and with "Fil" knob adjust meter needle to red line. If "Fil" knob must be turned all the way to the right to bring needle to red line, the batteries need replacing.
   (b) Testing B batteries:
   With set in operation, turn meter switch to "B volts." New batteries should read 180 volts. If meter indicates 120 volts or less, B batteries should be replaced.
2. Check batteries for correct wiring according to diagram on lid of battery box.
3. All battery connections must be tight.
4. See that battery cable is securely connected.
5. Pull back rubber covering on end of battery cable and see if all contacts are solid.
6. See that speaker cable is plugged firmly into jack.

Antenna Trouble:

1. See that antenna is connected.
2. See that antenna connection has not come in contact with front panel or other metal part of set.

3. See that antenna is properly installed. Lead-in wire should leave antenna at right angles.
4. Lead-in wire may be shortened to fit conditions but horizontal antenna wire must not be changed.
5. Antenna and lead-in wires must not touch trees, bushes or other objects.
6. Antenna should be at least 30 and preferably 50 feet in height.
7. Changing the direction of the antenna may increase the signal strength.

Receiver Trouble:

1. Check batteries and antenna.
2. Inspect headphone cord to see if it has been injured.
3. Dial adjustment is very sensitive. Tune slowly in order not to slip past a station.
4. The lower left hand switch should be turned to "Off" to receive voice and turned to "B.F.O." to receive code.

Transmitter Trouble:

1. Check batteries and antenna.
2. Check tuning adjustment. With set in operation, antenna connected and meter switch in "Trans. Tune" position, adjust knob in rear of set to lowest meter reading which should be between 1.5 and 2.0 on top meter scale. If meter needle moves continuously while knob is being turned, it indicates that transmitter is functioning properly.

General Trouble:

1. Don't give up the first time. Check the set-up and try again. No stations may be on the air. Some unusual atmospheric condition may be affecting reception. Conditions may be poor in the middle of the day and improve towards evening.
2. Try on a later schedule or try shifting the position of the antenna.
3. If you cannot get the station you want, contact another station and have them relay for you.
4. When the set is not in use the "Recv.-Trans." switch should be in the "Off" position. Also, disconnect the battery cable from the set as an added precaution.

SAFETY AND FIRST AID

Instruct men and take precautions to prevent all possible accidents; if any are incurred, treat injuries promptly and properly. Every employee of the Forest Service is expected to observe the following instructions.

HOW TO PREVENT INJURIES OR SICKNESS

1. Do not let men carrying sharp-edged tools walk close together. Have men carrying saws last in line.
2. Do not carry sharp-edged tools on shoulders.
3. Do not swing sharp cutting tools close enough to others to endanger them.
4. When chopping, look out for overhanging limbs or interfering brush.
5. Look out for falling timber or falling limbs and rolling rocks, logs, etc.
6. Drink water slowly if overheated.

IF INJURIES DO OCCUR

1. Get medical attention as soon as possible for all severe cases.
2. Give first aid promptly in all cases of injuries or serious illness.

FIRST AID

(*Immediate action imperative)

BURNS*

Cut off loose clothing and soak off the rest. Do not pull. Apply sterile gauze soaked in solution of: 1 tablespoon baking soda and 2 tablespoons epsom salts in 1 pint of warm boiled water. Keep moist. Spray with tannic acid solution if available.

BITES, INSECT

Apply cool, moist baking soda compress, using sterilized gauze and water.

All employees assigned to areas infested with fever-carrying ticks should be inoculated against spotted fever if they are likely to be in such areas during early spring months.

While most ticks do not carry spotted fever, any tick bite may result in serious infection if improperly treated.

To remove ticks fastened to the body, grasp gently with fingers and slowly pull straight from point of attachment. If tick's head is imbedded, care must be taken that it or one of the two mandibles (cutter-like mouth parts) are not pulled off and left in the skin. Any twisting motion made in pulling off the tick is almost certain to leave the mandibles in the skin and may result in infection.

After removing tick, paint spot with iodine. If excessive swelling or itchiness develops, see a physician.

BROKEN BONES*

Do not move patient unless absolutely necessary. Get physician if possible before moving more. If absolutely necessary to transport, put on splints. DO NO ATTEMPT TO SET BONES.

CUTS*

See wounds for procedure.

OVERCOME BY SMOKE*

Get immediately into clear air. Administer artificial respiration if necessary.

POISON OAK

Wash exposed parts with warm strong soap suds, and, if available, cleanse with rubbing alcohol.

POISONS, INTERNAL*

Try to induce vomiting at once and repeatedly with:

1. Ordinary soap suds.
2. Salt water.
3. Baking soda in water.
4. Fingers tickling throat if necessary.

After stomach is well cleared out, give large dose of epsom salts. Drink milk.

SHOCK*

Follows soon after most accidents. Symptons are: pale face, cold sweat, cold skin, pulse fast but weak; may have cramps, "all in." In cases of head or upper body injury, sun or heat stroke where face is red, lay patient down with head higher than feet. Give no stimulants. Apply cold rather than heat and give cold drinks. In all other cases, where face becomes white and pallid, lay patient down with head

a little lower than feet. Wrap warmly, apply heat to feet, between thighs, beside body or abdomen. If conscious, give hot drink of coffee, tea or water; one cup every half-hour.

SNAKE BITE*

1. Keep person quiet.
2. Apply tourniquet immediately above bite. Loosen this for few minutes every half-hour.
3. Make cross-cut incision over each fang mark.
4. Induce free, moderate bleeding.
5. Apply suction with suction cup or by mouth, if no wounds or sores in mouth.
6. Give no stimulants.

SPRAINS

1. Elevate injured limb.
2. Apply cold compresses.
3. Treat for shock, if present.

WOUNDS*

Not Bleeding Freely:

1. Clean if needed with rubbing alcohol, coal oil, benzine, naphtha or high-test gasoline.
2. Induce moderate bleeding.
3. Apply 3½ per cent solution iodine, once daily.
4. Let dry and apply sterile dressing and bandage. (Can use table salt as disinfectant.)
5. Do not touch with hands.

Wounds, Artery:

1. Apply large bandage dressing directly over wound.
2. Apply finger pressure over artery between wound and heart.
3. Apply tourniquet over external pressure point, loosening this for a few moments at least every half-hour.

LOOKOUT SAFETY RULES

PRECAUTIONS AGAINST LIGHTNING

All houses and towers located on points that are exposed to lightning must be equipped with the standard Forest Service protection approved by the Bureau of Standards.

All lookouts should be supplied with glass-legged stool on which to stand during severe lightning storms, particularly while telephoning when active lightning is near their stations and likely to come in on the wires.

Do not use the telephone while the storm is very close or overhead. Throw out the line switches during such periods, being sure to reestablish communication as soon as the danger is over. Put out fires in stoves when severe storm is approaching. Stay inside of the protected houses rather than to go out of doors. Keep away from contact with wires or metal objects even though they are insulated.

If caught out of doors, seek the protection of the dense timber, caves, deep canyons or overhanging cliffs, if any are available.

See that a copy of the Standard Rules is kept posted in each lookout or exposed building.

Keep remote safety switch on telephone line open during severe and nearby lightning storms. Use rope (not wire) for control of switch from catwalk.

PRECAUTIONS AGAINST FALLS

1. Use a flashlight or lantern when going up or downstairs at night.
2. Keep inside trap doors to stairs closed except when stairs are in actual use.
3. Keep catwalk trap doors closed except during heavy visiting periods. When catwalk trap doors are open, be sure the bar at the open end of the stair well is in a safety position.
4. Warn visitors of the danger of falls, and see that children are not allowed on catwalk unattended.
5. Keep catwalk and stairs absolutely free of chairs, boxes, tools or any objects whatever.

PRECAUTIONS AGAINST FIRE

1. Fill gasoline lanterns outside.
2. Have definite daylight hour for filling gas lanterns. Never fill when lighted or warm.
3. If gasoline or kerosene stove is used, fill detachable reservoirs outside. In filling other types, be sure room is well ventilated.
4. Do not use inflammable cleaning fluid inside.
5. Dispose currently of all oily rags.
6. Observe standard instructions in the storage of gasoline and the filling of car gasoline tanks.
7. Keep storage room clean and neat. Avoid accumulations of old newspapers, magazines, sacks, rags, paint cans, etc.
8. Keep a supply of water on hand, sufficient to extinguish a small roof fire; 5 gallons or more.

GLOSSARY OF TERMS USED IN FOREST FIRE CONTROL

Absolute Humidity—See Humidity, absolute.

Actionable Fire—A fire started or allowed to spread in violation of any law or regulation.

Alidade—A straightedge equipped with sights; an essential part of a device for locating fires.

Anemometer—An instrument for measuring wind velocity in miles per hour or other units.

Aneroid Barometer—An instrument which indicates atmospheric pressure and usually the elevation above sea level. The actuating element consists of partially exhausted, thin, corrugated metallic cells.

Appalachian Scale—See Scale, Appalachian.

Area Needing Protection—In general any acreage needing systematic fire control to avoid serious damage to watersheds or other damage to the land or the growth thereon or to safeguard adjacent lands or other values. For estimate and allotment purposes on national forests, the term includes all acreage inside the legal boundaries of national forests and approved purchase areas, less the following deductions:

(a) Portions of approved purchase areas on which organized fire control has not been established.

(b) Blocks of barren lands, non-inflammable grass or water surface even if lying in two adjacent forests, if larger than 9 square miles, on which fires will not start or will not run far enough to cause concern. The high Sierra in California, Mt. Hood and areas in Colorado above timber line are the most perfect examples.

(c) Solid blocks of more than 9 square miles of private or State land which are protected by the owners, directly or through agencies other than the Forest Service.

Atmospheric Visibility—See Visibility, atmospheric.

Attack Time—See Elapsed time.

Azimuth—The angle measured from the north in a clockwise direction, which any line makes with the true north and south reference line.

Azimuth, Back—Azimuth plus 180 when azimuth is 180 or less. Azimuth minus 180 when azimuth is more than 180.

Azimuth Circle—A circle graduated in degrees in a clockwise direction.

Back Azimuth—See Azimuth, back.

Backfire—A fire intentionally set on the fire side of a control line as a part of the process of controlling a fire. (Using such a fire when the control line is close to the fire edge is sometimes called "burning out" or "clean burning.")

Base Camp—See Camp, base.

Beaufort Scale—See Scale, Beaufort.

Berm—The raised shoulder on down-hill side of trench.

Blind Area—Area where the ground or the vegetation growing thereon can not be seen directly from any established lookout station or point, or by any lookout cooperator, when atmospheric visibility is normal. See Seen area.

Boss—A man responsible for certain definite activities on a fire. The following terms should not be confused with payroll titles:

Fire Boss—The man in charge of all operations on a fire.

Division Boss—The man who on a large fire has charge of two or more sectors. See Sector.

Sector Boss—The man in charge of a defined section of the perimeter of a fire and supervising two or more crews.

Crew Boss—The man in charge of a group of men composing a crew unit larger than a straw-boss unit. (Sometimes called "foreman." When necessary, has straw bosses working under his supervision.)

Straw Boss—The man directly supervising the work of a small group of men under the direction of a "crew" or other boss.

Patrol Boss—The man in charge of patrol and mop-up after control-line construction.

Camp Boss—The man in charge of camp activities in the fire camp. (Sometimes called "camp manager.")

Brush—A standing woody growth of species that do not form forests, e.g., chaparral, scrub oak, etc. (Not to be confused with slash, debris, or reproduction.)

Burning, Controlled—The use of fire as a tool in forest protection and management; burning that is confined, according to a plan, to specific areas and intensities of heat.

Burning, Light—The use of fire at intervals in broadcast burning on the theory that such repeated fires will consume much of the forest fuels and so reduce the volume of these materials that accidental fires would cause less damage and would be controlled more easily.

Burning Period—That part of the day when a fire spreads more rapidly than at any other time. (Usually thought of as the "heat of the day," but may also occur during the night under adverse fire-weather conditions.)

Camera, Photo-Transit—See Photo-transit camera.

Camp, Base—The central base, usually only on larger fires, for the assembly and distribution of men, equipment, and supplies. See Camp, side.

Camp Boss—See Boss.

Camp Manager—See Boss, camp.

Camp, Side—A fire camp, usually small, for accommodating a crew working on an isolated section of a fire. (Sometimes called "spike camp.") See Camp, base.

Cat Face—See Fire scar.

Causative Agencies—The causes or agencies responsible for the origin of forest fires. See Causes of fires.

Causes of Fires—The eight standard major causes of forest fires recognized in national forest practice are:

Camp Fire—Fires resulting from fires started for the purposes of cooking, warming, or providing light by persons camping or traveling on or near wild land, except those started by railroad or lumbering employees in connection with their duties.

Debris Burning—Fires resulting from any fires originally set for clearing land for any purpose, or for rubbish, garbage, range, stubble, or meadow burning without intent on the part of the burner to have such fires spread to lands

not intended to be burned. (This does not include lumbering fires or hazard reduction on rights-of-way of common-carrier railroads.)

Incendiary—Fires that in the judgment of the reporting officer are deliberately set by anyone with the intention of burning over land or damaging property not owned or controlled by him.

Lightning—Fires caused directly or indirectly by lightning.

Lumbering—Fires, except those caused by smokers, resulting from lumbering operations. (Lumbering operations include all activities connected with the harvesting or processing of wood for use or sale. Lumbering fires will include those caused by logging railroads which are not common carriers.)

Railroad—Fires resulting from maintenance of rights-of-way or construction or operation of common-carrier railroads.

Smoker—Fires caused by smokers' matches, or by burning tobacco in any form.

Miscellaneous—Fires that cannot be properly classified under any of the seven standard causes just listed. (Fires of unknown causes should be classified under the most probable cause and not under "Miscellaneous.")

Character of Fires:

Smoldering—A fire making no appreciable spread and burning without flame.

Creeping—A fire spreading slowly, usually with low flame.

Running—A fire spreading rapidly and with a well-defined head but without spotting or crowning.

Spotting—A fire spreading as a result of sparks or embers falling ahead and starting new fires.

Crowning—A fire advancing primarily from crown to crown rather than from ground to crown. See Types of fires.

Checking Station—A contact point on main routes of travel, usually at or near the boundary of the forest, where traffic is checked and travelers contacted as a fire-prevention measure. Sometimes called "registration station."

Class A Fire—A fire of one-fourth acre or less.

Class B Fire—A fire of more than one-fourth but less than 10 acres.

Class C Fire—A fire of 10 acres or more but less than 100 acres.

Class D Fire—A fire of 100 acres or more but less than 300 acres.

Class E Fire—A fire of 300 acres or more.

Classification, Control-Line—See Control-line classification.

Climate—The long-time average, or generally prevailing weather conditions of any locality. See Weather.

Cloudiness—The fraction of the sky covered by clouds. It is estimated in tenths and expressed as follows:

Clear	.0 to .7 covered
Partly cloudy	.4 to .7 covered
Cloudy	.8 to completely overcast

Closed Area—An area in which, because of the fire danger, travel is prohibited or restricted for temporary periods.

Cold Trailing—Very careful inspection of a partly dead fire edge, digging out any live spots or trenching short pieces of live edge, and feeling with hands where there is any doubt as to whether any fire remains.

Constant Danger—See Danger, constant.

Control a Fire—To surround a fire and any spot fires therefrom, with control lines and complete the backfiring of any unburned surface adjacent to the inner edge of the control lines.

Controlled Burning—See Burning, controlled.

Control Line—An inclusive term for all the constructed or natural barrier used in controlling a fire. Includes (1) clearing when that is necessary, (2) the fire line when that is needed, (3) removal of immediate threats to line constructed, (4) the edge of a grass or other fire which has been worked by direct method, (5) roads, lakes, bare rock, or other natural barriers used in controlling a fire.

Control-Line Classification—The principal classes of control-line construction methods with respect to distance from the fire edge are:

Direct Method—A method of suppression that applies work immediately at the edge of the fire. (Includes building a control line there, beating out, extinguishing with water or earth, digging out and shoveling in burning materials, etc.)

Two-Foot Method—A method of suppression in which a fire line is constructed not over 2 feet from edge of fire. (It contemplates no backfiring, and aims to leave a minimum strip of unburned material. The distance from the edge permits safer used of hand tools than the direct method.)

Parallel Method—The method used in suppression when a continuous fire line is constructed parallel to but within 100 feet from the edge of the fire and the intervening strip is immediately burned out. (The object is to keep just far enough away from the fire to enable men to work most efficiently.)

Indirect Method—Under this method the control line is located along favorable breaks in topography or natural firebreaks, and the intervening strip is backfired. (By implication any control line more than 100 feet from the edge represents application of the indirect method, even if the line is not located along a break in the topography.)

Control Time—See Elapsed time.

Controlled—See Control a fire.

Cooperator, Fire—A local person or resident with whom arrangements have been made in advance (1) to furnish incidental detection service at no charge or (2) to fight or to direct the action on fires in his vicinity with or without compensation, or (3) to be available for full-time service with pay. Limited authority to hire crews and to incur other expenses in fighting fires is often delegated to cooperators in advance. Called by various local terms, such as "fire agent," "key man," "warden," "per diem guard."

Coverage—The extent to which some standard such as travel time or detection has been met by an existing or a planned system.

Crew Boss—See Boss.

Crown Fire—See Types of fires.

Cumulative Relative Humidity—See Humidity, cumulative relative.

Damage, Fire—See Fire damage.

Danger Board—A danger meter specially designed for display purposes. See Danger meter.

Danger Class—A numerical or percentage rating of the variable fire danger existing at a given time.

Danger, Constant—A term used to include all phases of fire danger which are, for a given area, relatively unchanging, e.g., normal risk, topography, all fuels, exposure to prevailing wind, etc. See Danger, variable.

Danger, Fire—A general term expressing the sum total of both the constant and the variable factors which determine whether fires will start, spread, and do damage and that determine their difficulty of control. (Constant factors include values at stake, normal occurrence, fuel type, slope, aspect, soil type, etc. Variable factors include lightning, incendiary epidemics, illegal burning, inflammability, wind velocity, etc.)

Danger Meter—A device which by integrating the combined effect of the more significant variable fire-danger elements, rates current fire danger into specific classes. (For each class, the specific fire-control measures which should be taken are indicated in some appropriate way.) See Danger board.

Danger, Variable—A term used to include all phases of fire danger of a given area which vary from day to day and result in producing variations of danger within the season and from year to year, e.g., all weather elements, fuel moisture content, variable man-caused hazards, etc. See Danger, constant.

Debris Burning—See Causes of fires.

Detection—The act or system of discovering and locating fires.

Direct Method—See Control line classification.

Direction, Wind—See Wind direction.

Discovery—The act of determining the existence of a fire. Differs from detection in that location is not required. See Detection.

Discovery Time—See Elapsed time.

Dispatcher—A member of the fire-control organization who receives reports of discovery and status of fires, determines the locations of fires, and sends men, supplies, and equipment to suppress fires. (A central dispatcher functions over an entire forest or several ranger districts; a ranger district dispatcher, within a ranger district only.)

Division—A group of two or more sectors on a large fire. (Size of division should be no larger than the division boss can supervise and inspect adequately each shift.)

Division Boss—See Boss.

Drift—The term used by lookout men to give the direction taken by smoke from a fire, particularly in describing fires the bases of which are partially or wholly unseen, but are evidenced by smoke rising above the obstruction.

Drift Smoke—Smoke from fires or industrial activities which is moved by air currents into other areas.

Dry Storm—A lightning storm with less than 0.10 inch of precipitation measured or estimated as reaching the ground.

Duff—The dead organic material making up a part of the forest floor.

Duff Hygrometer—An instrument for measuring the moisture content of the litter or duff.

Economic Theory—A theory of forest fire control which postulates that the object of control is to keep total cost (prevention plus presuppression plus suppression plus damage) to a minimum. (Abbreviated as minimum P + P + S + D or, least cost or least cost and damage. See Minimum-damage theory.)

Edge, Fire—See Fire edge.

Effects, Fire—Any consequence—neutral, detrimental or beneficial—resulting from fire.

Effects, Net Fire—The sum of all effects, both detrimental and beneficial, resulting from burning.

Elapsed Time—The difference in time between the beginning of any fire control action and its actual accomplishment:

Discovery Time—Elapsed time from start of fire (known or estimated) until the time of the first discovery which results directly in subsequent suppression action.

Report Time—Elapsed time from discovery of a fire as defined above until the first man who goes to the fire is notified of the existence and location of the fire.

Attack Time—Elapsed time beginning when the man to perform first effective work on a fire learns that there is a fire and ending when he begins first control work.

Control Time—Elapsed time from first effective work until fire is controlled. See Control a fire, and Control line.

Mop-Up Time—Elapsed time from completion of controlling process until enough mop-up has been done to insure that the fire will not break out.

Elapsed Time Standards—Definite maximum allowable periods of time set for various steps of the suppression job.

Emergency Rations—See Rations, emergency.

Equipment, Fire—See Fire control equipment.

Extra-Period Fire—A fire not controlled by 10 a.m. of the day following discovery.

Fag Station—An area fireproofed and signed to allow smoking in a restricted area in forests closed to smoking.

False Alarm—(1) A smoke or fire reported but requiring no actual suppression, e.g., donkey engine, brush burning under control, and (2) any phenomenon reported as a fire but upon investigation found not to be a fire, e.g., dust from a band of sheep. See Smoke, false.

False Smoke—See Smoke, false.

Fan Psychrometer—See Psychrometer, fan.

Feeling for Fire—Act of following an edge of a burn after fire is apparently out, and feeling with bare hands the burned edge to determine if ground fire still exists.

Fingers of a Fire—See Parts of a fire.

Fire Assistant—A man specially qualified in fire control, who, acting under the general direction of the forest supervisor, specializes in the study of fire problems and in the execution of fire-control activities.

Fire Behavior—A general term used to describe the action of fire as a result of the complex of variable factors that influence it.

Fire Boss—See Boss.

Firebreak—A partially or wholly cleaned barrier constructed before a fire occurs and designed to stop or check fires that may occur, or to be used as a line from which to work.

Fire Chief—The man in charge of fire control activities of a region, State, or association. (Not to be confused with "fire assistant" or "fire boss.")

Fire Control—Protection of wild land and the growth thereon from fire. (Includes prevention, presuppression, and suppression.)

Fire-Control Equipment—All the tools, conveyances, machinery, and special instruments or devices purchased for or allocated to fire-control purposes, but not including structures.

Fire-Control Improvements—The structures used in fire control, e.g., lookout towers, guard cabins, telephone lines, roads, trails, etc.

Fire-Control Planning—A technological and administrative management process used in preparing for action in protecting wild land from fire.

Fire Damage—(1) The value expressed in money or otherwise, of the loss tangible or intangible, caused by fire; (2) a general term applying to the destructive effects of forest fires either (a) direct, e.g., killing or burning of trees, forage, and crops; destruction of fish and game, scenery or facilities for recreation; destruction of improvements; and loss of human life; or (b) indirect, e.g., reduction in rate of growth resulting from site deterioration; physical injury such as wounding; subsequent attack by fungi and insects; reduction in watershed values resulting from the destruction of the infiltration capacity of the soil; destruction of favorable conditions for wildlife; and depreciation in property or social values.

Fire Danger—See Danger, fire.

Fire-Danger Board—See Danger board.

Fire-Danger Class—See Danger class.

Fire-Danger Meter—See Danger meter.

Fire-Danger Station—See Station, fire-danger.

Fire Dispatcher—See Dispatcher.

Fire Edge—The line, usually irregular, to which a fire has burned at a given moment.

Fire Effects—See Effects, fire.

Fire Foam—A term applied to the product of various chemicals which when mixed with water, cause a great increase of volume by forming froth or bubbles, which may or may not be filled with noninflammable gas. (The bubbles adhere to the burning fuel and reduce combustion by excluding oxygen as well as by cooling and moistening.)

Fire Guard—See Guard, fire.

Fire Hazard—See Hazard.

Fire Line—The strip which, when necessary, is scraped or dug to mineral soil in a control line; a part of a control line. (Fire line exists only when it has been necessary to remove inflammable material from a narrow ribbon of mineral soil. The edge of a grass fire which has been beaten out is a control line but not a fire line.)

Fire-Line Patrol—See Patrol.

Fireman—A guard whose dominant function is suppression. (He generally stays at a fixed point awaiting an order to go to and suppress a fire.) See Lookout-fireman, smokechaser.

Fire Pack—A unit of tools, supplies, and equipment prepared in advance for immediate and convenient transportation to a fire.

Fire, Parts of—See Parts of a fire.

Fire Patrol—See Patrol.

Fire Prevention—See Prevention.

Fireproof—To treat an area, hazard, road, etc., so as to reduce the danger that fires will start or spread, e.g., to fireproof a roadside or campground.

Fire Protection—Synonymous with "fire control" which is the preferred term.

Fire Scar—The physical evidence in the form of a superficially healed fire wound or cavity.

Fires, Causes of—See Causes of fires.

Fires, Character of—See Character of fires.

Fires, Class of—See Class A to E fire.

Fire Season—The period or periods of the year during which fires are likely to occur, spread, and do sufficient damage to warrant organized fire control.

Fire Suppression—See Suppression.

Fire Trap—An accumulation of highly inflammable material or any situation in which it is dangerous to fight fire on a bad day.

Fires, Types of—See Types of fires.

Fire Warden—See Cooperator, fire.

Fire-Weather Forecast—A weather prediction specially prepared by the U. S. Weather Bureau for use by forest fire control agencies. [Three types are issued (1) a "general outlook" for 2 to 3 days; (2) a "daily forecast" for the ensuing 36 to 48 hours; and (3) "special localized forecasts" for short periods (3 to 12 hours) when requested.]

Fire-Weather Station—See Station, fire-weather.

First Work Period—Time between discovery of fire and 10 a.m. of following calendar day. (Second and succeeding work periods are 24 hours long beginning at 10 a.m.)

Flanks of a Fire—See Parts of a fire.

Flanking—A method of attacking a fire by working around either edge, usually from the point of origin, and endeavoring eventually to pinch it out by connecting the two flank lines at the head of the fire.

Flash Fuels—See Fuels, flash.

Foam—See Fire foam.

Follow Up—The act of supporting the first man or men who go to a fire by sending additional manpower to facilitate either suppression or mop-up work.

Foreman—See Boss, crew.

Forest Fire—A fire burning on wild land in peat, duff, litter, ground cover, or crowns and not being used as a tool in forest protection or management in accordance with an authorized plan.

Forest Protection—The activities connected with the control of damage to forests from fire, insects, disease, and other harm-producing agencies.

Forest Pyrology—The science of protecting forests from fire.

Freeburning—Used to describe a fire or portion of the perimeter of a fire on which no work has been done to hinder or stop its spread.

Front of a Fire—See Parts of a fire.

Fuel-Moisture-Indicator Sticks—Specially prepared wooden sticks of known dry weight, which are exposed and weighed periodically to determine their change in moisture content which indicates the change in moisture content of lightweight forest fuels.

Fuel Reduction—Any action taken to reduce the volume of fuel as by burning. See Hazard reduction.

Fuels, Flash—Light fuels such as grasses, ferns, tree moss, etc., which ignite readily and are consumed very rapidly and thus contribute to very rapid rate of spread.

Fuels, Heavy—Fuels such as snags, windfalls, branchwood, etc., which, while they usually burn more slowly than flash fuels, liberate a greater amount of heat and burn more fiercely, thus materially increasing the difficulty of suppression.

Fuel-Type Classification—The division of forest areas into units according to both the normal rate of spread of fire on an average bad day, and the resistance to control line construction offered by the fuels, topography, and soil.

Gravity Chance—Physical conditions that offer an opportunity to put water on a fire by the force of gravity alone.

Gridiron Method—A method of finding a small fire. (The fireman paces a certain distance at right angles to the line of sight from lookout station, then runs a compass line parallel to the line of sight, repeating the process if necessary, to cover a considerable area on each side of the line of sight.)

Ground Fire—See Types of fires.

Guard, Fire—A general term applied to patrolmen, firemen, lookout men, and others, who, working under direct supervision of a district ranger, are employed during the fire season for the prevention, and suppression of fires, and presuppression activities.

Guard, Per Diem—See Cooperator, fire.

Guard Unit—A natural unit, usually part of a ranger district, assigned to a fire guard.

Gutter Trench—A ditch dug on a slope below a fire; designed to catch rolling cones, small chunks, and other rolling burning material. See Control line, fire line.

Hang-Over Fire—A fire started by lightning which remains dormant until a later period when it becomes active. (Includes a lightning fire when the lookout man sees the strike or smoke but which subsides before ground forces are able to locate it until subsequent rediscovery. Does not include fires merely difficult to find.)

Hazard—A term applied to materials which form a threat of special suppression difficulties if ignited, and which it is practicable to treat in ways which will remove or diminish the threat. (For example: Snags; jungles of windfalls; fuels immediately adjacent to roads or railroads; fuels around village dumps, ash dumps, or buildings; such dumps and buildings themselves as distinct from the fuels surroundlng them; the burnable materials collected at small sawmills; old sawdust piles; meadows covered at certain times with inflammable grass; and man-made debris around homes.)

Hazard Reduction—The removal, destruction, or treatment of inflammable physical materials, at any time other than on a going forest fire, for the purpose of diminishing the chances of fires starting or spreading. "Physical materials" may or may not include those included in the terms "flash" or "heavy" fuels.

Haze—A condition of the atmosphere due to the presence of light vapor, fine dust or smoke, which impedes vision and decreases the transparency of the atmosphere; also produced at times by optical irregularities in the atmosphere.

Haze Meter—See Visibility meter.

Head of a Fire—See Parts of a fire.

Held Line—All worked line which has not been abandoned for a line on a new location when control and mop-up are completed. (Lost line, unbackfired natural barriers, and unused safety lines are excluded.)

Herbaceous Stage—A term applied to the current inflammable condition of herbaceous vegetation. (Three stages are generally recognized—green, curing, and cured.)

Hold-Over Fire—See Hang-over fire.

Hot Spotting—Checking the spread of the fire on main leads or at salient points as an emergency measure employed in advance of control line construction.

Hour Control—A term used to describe the elapsed time, from origin of a fire to arrival of the first man or men of a given suppression force, required to hold acreage burned to a predetermined area for a given unit or cover type.

Humidity, Absolute—(1) The mass of water vapor per unit volume of space, (2) the gaseous pressure exerted by water vapor present in a space.

Humidity, Cumulative Relative—The algebraic sum of the departures from or differences between daily relative humidity readings and a fixed base.

Humidity, Relative—(1) The ratio of actual mass of water vapor per unit of volume to mass of water vapor that would saturate that volume at the same temperature and pressure; (2) the ratio of actual vapor pressure to saturated vapor pressure at the same temperature. In the forest fire weather forecasts issued by the U. S. Weather Bureau relative humidity forecasts are modified by the following terms, the changes indicated referring to the previous corresponding 24-hour period:

Higher Humidity—Modified by the following terms to indicate magnitude of expected change:

Slightly—Change of 5 per cent or less.
Somewhat—Change of 6 to 15 per cent.
Materially—Change of 16 to 30 per cent.
Decidedly—Change of 31 per cent or more.

Lower Humidity—Modified by the terms given under "Higher" to indicate magnitude of expected change.

Little Change—Change of less than 5 per cent expected.

Maximum or Minimum—The maximum or minimum humidity expected during the period is indicated by specific figures.

Rising or Falling—Progressive change in the direction indicated. The approximate level of relative humidity expected during the next 24-hour forecast period is indicated by these terms:

Very High—More than 80 per cent.
High—61 to 80 per cent.
Moderate—41 to 60 per cent.
Low—21 to 40 per cent.
Very Low—11 to 20 per cent.
Acutely Low—10 per cent or less.

Becoming—Used to indicate a change from either a higher or lower humidity level and used in connection with the foregoing terms.

Humidity: Relative-Humidity Tables—Psychrometric tables giving only the relative humidities prevailing at different combinations of wet- and dry-bulb temperatures for specific barometric pressures or elevations above sea level.

Hygrograph—A self-recording instrument for measuring relative humidity.

Hygrometer, Duff—See Duff hygrometer.

Hygrothermograph—An instrument which measures and automatically records both relative humidity and temperature on a single chart.

Incendiary Fires—See Causes of fires.

Independent-Action Fires—Fires in which some part or all of the suppression action up to first effective work is taken independently by other than organized cooperators or forest service presuppression forces.

Indirect Method—See Control line classification.

Inflammability—The relative case with which fuels ignite and burn regardless of the quantity of the fuels.

Key Man—See Cooperator, fire.

Knock Down—To treat the most vigorously flaming portions of the fire edge until they are not spreading rapidly or creating any great heat. (A process used in hot spotting.)

Least-Cost Theory—See Economic theory.

Legitimate Smoke—See Smoke, legitimate.

Light Burning—See Burning, light.

Lightning Fires—See Causes of fires.

Line Patrol—See Patrol.

Litter—The top layer of the forest floor which consists of loose debris of dead sticks, branches, twigs, and recently fallen leaves or needles, the structures of which have been little altered by decomposition.

Logging Fires—See Causes of fires, lumbering.

Lookout—Term should not be used alone due to possible confusion. See Primary lookout, Lookout-fireman, Lookout man, Lookout point, Lookout station, Lookout tower.

Lookout Dispatcher—A lookout man, who, in addition to detection duties, handles fire dispatching for a ranger district.

Lookout-Fireman—A guard placed at a lookout station, whose duties combine the functions of lookout man and fireman.

Lookout House—A building containing living quarters and with walls largely of glass, constructed on a natural or artificial elevation to permit unobstructed view of the entire horizon from its interior.

Lookout Man—A guard placed at a lookout station to detect and report fires.

Lookout Observatory—A small building with walls largely of glass on or separate from a tower, to be occupied by a lookout man but not designed for living quarters. (Not to be confused with "lookout house.")

Lookout Patrolman—A guard who traverses ridges and other topographic features of vantage, whose function is to discover, locate, report. and suppress fires in a locality, much of which is not visible from any lookout point.

Lookout Point—A general term for topographic vantage points systematically selected for detection purposes.

Lookout, Primary—A lookout station occupied by a lookout man who is not sent to fires. See Lookout-fireman.

Lookout Station—A general term for the location and structures used for detecting and reporting fires. (Includes planned cooperator lookout stations.)

Lookout Station, Temporary—A detection station occupied only occasionally when special needs arise, e.g., if visibility is reduced by drift smoke or in times of unusually high danger.

Lookout Tower—A structure erected to enable the lookout man to get above nearby obstructions to vision. It may be capped with a lookout house or an observatory, the latter being too small for living quarters.

Lumbering Fires—See Causes of fires.

Map, Fire-Progress—A map maintained on a large going fire showing sectors and divisions, status of control-line construction, some culture, and the most salient topographical factors. (Posted periodically or whenever information comes in.)

Map, Occurrence—A map showing by suitable symbols the starting points of all fires of various classes or causes for a given period.

Map, Panoramic-Profile—A special map drawn around the circumference of a fire-finder map to show the profile of the topography as it appears from the lookout point.

Map, Panoramic-Photograph — Panoramic photographs from a lookout point, on which azimuths and vertical scales have been marked, for use in connection with a fire finder to locate fires.

Map, Seen-Area—A map showing the particular territory in which either the ground surface or the vegetation growing thereon is seen direclty up to some predetermined radius from a lookout point.

Map, Travel-Time—A map indicating the length of time required to reach various parts of a unit by the initial action fireman or crew when the planned positions are occupied.

Map, Water-Supply—A map showing location of supplies of water readily available for pumps, tanks, trucks, camp use, etc.

Maximum Thermometer—A special type of thermometer that registers the highest air temperature between settings of the instrument.

Measurable Precipitation—Precipitation equivalent to rainfall of 0.01 inch or more. Less than that amount is termed a trace.

In the forest fire weather forecasts issued by the U. S. Weather Bureau, precipitation forecasts are modified by the following terms:

Light—Less than 0.10 inch of rain, or less than a 1-inch layer of snow.

Moderate—Between 0.10 inch and 0.50 inch of rain, or between a 1- and 5-inch layer of snow.

Heavy—More than 0.50 inch of rain, or more than a 5-inch layer of snow.

Meter, Fire-Danger—See Danger meter.

Minimum-Damage Theory—A theory of forest-fire control which assumes or asserts that the objective is to keep fire damage to a minimum. See Economic theory.

Minimum Thermometer—A special type of thermometer that registers the lowest air temperature between settings of the instrument.

Miscellaneous Fires—See Causes of fires.

Mopping Up (Mop-Up)—The act of making a fire safe after it is controlled, such as extinguishing or removing burning material along or near the control line, felling snags, etc.

Net Fire Effects—See Effect, net fire.

Non-Statistical Fires—See Statistical fires.

Normal Season—A season in which weather, rated fire danger, and number and distribution of fires are approximately average.

Northern Rocky Mountain Scale—See Scale, Northern Rocky Mountain.

Occurrence Map—See Map, occurrence.

Palouser—A light for night travel improvised from a candle and a tin can. (Often called a "bug.")

Panoramic-Photograph Map—See Map, panoramic-photograph.

Panoramis-Profile Map—See Map, panoramic-profile.

Parallel Method—See Control line classification.

Parts of a Fire:

Fingers of a Fire—The long narrow tongues of a fire projecting from the main body.

Flanks of a Fire—The portions of the edge of a fire between the head and the rear.

Head of a Fire—The portion of the edge of a fire on which rate of spread is most rapid.

Rear of a Fire—The portion of the edge of a fire on the windward or downhill side.

Patrol—(1) The act of moving over a given route to contact and impress people with the need for care with fire. (2) The act of moving over a given route to prevent, detect, and suppress fires. (3) The act of moving back and forth over a length of control line during or after line construction, to prevent breaks, discover spot fires, and when time permits, do mop-up work.

Patrol Boss—See Boss, patrol.

Patrol Line—See Patrol (3).

Patrolman, Lookout—See Lookout patrolman.

Patrol Observatory—A post, tower, tree, or designated point close to a travel route and which is shown on the plotting map. (Readings from these points can be plotted in the same way as those from the regular lookout points.)

Patrol Route—A line of travel followed by a man assigned to patrol. (May or may not be a predetermined route.)

Per Diem Guard—See Cooperator.

Perimeter of a Fire—(1) The entire outer edge of the fire. (2) The length of the outer line or edge of the fire.

Photo-Transit Camera—A special type of panoramic camera that records the vertical angle and the true azimuth of objects photographed on the landscape in relation to the photographic station.

Precipitation, Measurable—See Measurable precipitation.

Preparedness—(1) Condition or degree of being completely ready to prevent or suppress fires. (2) Mental readiness to recognize increases in fire danger and act promptly when action is appropriate.

Presuppression—Those fire-control activities concerned with the organization, training, instruction, and management of the fire-control organization, and with the inspection and maintenance of fire-control improvements and equipment and supplies to insure effective fire suppression. See Fire control, prevention, suppression.

Prevention—Those fire-control activities concerned with the attempt to reduce the number of fires through education, hazard reduction, law enforcement, etc., or to hold the number down after they have been reduced to a satisfactory level. (Not a part of presuppression.) See Fire control, preparedness, presuppression, suppression.

Primary Lookout—See Lookout, primary.

Protection Forest—An area covered with woody growth, managed primarily for its beneficial effects on water, or soil movement rather than primarily for wood or forage production.

Protection, Forest—See Forest protection.

Protection Improvements—See Fire-control improvements.

Psychrometer—An instrument for measuring atmospheric relative humidity, and consisting usually of two thermometers, the bulb of one being covered with cloth which is moistened and thoroughly ventilated when the instrument is used.

Psychrometer, Fan—A type of psychrometer in which a current of air is circulated across the wet- and dry-bulb thermometers by means of a small fan.

Psychrometer, Sling—A particular type of psychrometer in which the instrument is secured to a cord, chain, or handle so that the psychrometer can be whirled rapidly in order to insure a large quantity of air coming in contact with the two bulbs thus accomplishing adequate ventilation of the wet-bulb thermometer.

Psychrometric Tables—Tables showing the relative humidity, dew point, vapor pressure, etc., prevailing at different combinations of wet- and dry-bulb temperatures for specific barometric pressures or elevations above sea level. See Humidity, absolute; humidity, relative.

Pump Chance—Natural source of water near enough to a fire and in sufficient quantity for effective use of power pumps in suppression.

Radius of Vision—See Vision, radius of.

Railroad Fires—See Causes of fires.

Rain Gage—An instrument for measuring the amount of precipitation; it consists usually of a vessel to catch the rain and a measuring stick for determining its depth.

Range of Vision—See Vision, radius of.

Rate of Spread—The increase in size of a fire expressed in chains of perimeter per hour or some other similar units.

Rating, Danger—See Danger meter.

Ration—A quantity of food sufficient to supply one man one day.

Rations, Emergency—Food assembled in advance in standard units of varying sizes and held ready for instant use of men responsible for suppressing fires.

Rear of a Fire—See Parts of a fire.

Re-Burn—Second burning over of an area inside a control line over which fire previously ran but did not consume all inflammable material.

Relative Humidity—See Humidity, relative.

Relative Humidity Tables—See Humidity; relative humidity tables.

Report Time—See Elapsed time.

Reporting Incendiary Fires—See Sets.

Resistance to Line Construction—A term used to express the relative difficulty of constructing control line as determined by the character and density of fuels, soil conditions, and topography. It may be expressed in chains of held line per man hour or as extreme, high, medium, and low.

Risk—The relative chance or probability of fire starting, determined by the presence or absence of causative agencies. (A part of the fire danger on any area.)

Rough—A term used in the southern pine regions to denote the aggregate of living and dead plant materials that occurs upon or close to the ground following the exclusion of fire. (Roughs are classified either on the basis of composition [by species] or on age [number of years since last burning].)

Scale, Appalachian—A modification of the Beaufort scale specifications, devised by the Appalachian Forest Experiment Station. (It is based on conditions in the forested portions of the Southern Appalachian Mountain Region.)

Scale, Beaufort—An empirical scale in which the strength of wind is indicated by numbers from 0 to 12. (The original Beaufort scale was designed for use at sea. A Beaufort scale with specifications for land use is used today by the Weather Bureau.)

The following terms are those used by the weather bureaus in forecasting:

Forecast Terms	*Wind Velocity Miles per Hour*
Calm	Less than 1
Very Light	1-3
Light	4-7
Gentle	8-12
Moderate	13-18
Fresh	19-24
Strong	25-38
Gale	39-54
Whole Gale	55-75
Hurricane	Over-75

Scale, Northern Rocky Mountain—A modification of the standard Beaufort scale specifications devised by the Northern Rocky Mountain Forest and Range Experiment Station. (It is based on conditions in the forested portions of the Northern Rocky Mountain Region—western Montana and northern Idaho.)

Sector—A logical or natural length of the control line handled as a unit for suppression purposes. (Normally a sector should not exceed the amount of line the man in charge [sector boss] can supervise and inspect adequately each shift.)

Sector Boss—See Boss, sector.

Seen Area—An area where the ground or the vegetation growing thereon can be seen directly from any established lookout point under prescribed atmospheric conditions. See Blind area.

Sets—A term used in connection with incendiary fires. National forest rules for reporting such fires are:

(a) Where all sets burn together and are suppressed as one fire, all will be reported as one fire.

(b) All individual sets suppressed, will be reported as one fire except in cases where more than one-quarter mile intervenes between any two adjacent sets. In this event, two or more fires will be recognized.

Short Term Men—Personnel employed for any forest work, in positions which are set up for less than the full 12 months of the calendar year. (When employed for prevention or presuppression are included regardless of the shortness of the period of employment. Men employed partly or wholly for suppression throughout a fire season or a period of consecutive fire days are included if not continuously occupied on suppression, but men employed to suppress a particular fire or a continuous series of fires are excluded.)

Side Camp—See Camp, side.

Sling Psychrometer—See Psychrometer, sling.

Smoke Candle—A pyrotechnical product used for the production of smoke simulating a small fire and used in testing efficiency of lookout men and determining visibility distance. See Test fire.

Smokechaser—Any guard who goes to fires.

Smoke, Drift—See Drift smoke.

Smoke, False—Any phenomenon which is likely to be reported as a fire. (Sheep dust, gray cliff, fog, etc.) See False alarm.

Smoke Haze—The light deceptive smokiness caused by diffusion of smoke from past or distant fires is usually called smoke haze.

Smoke, Legitimate—Smoke resulting from locomotive, industrial operations, ranches, etc., and not from forest fires.

Smoker Fires—See Causes of fires.

Snags—Standing dead trees or parts of dead trees. (Snags less than 6 feet high are classed as stumps.)

Speed and Strength of Attack—The time control (elapsed time from origin of fire to arrival of first man) and manpower necessary to hold burned area to an acceptable or predetermined limit within a specific fuel type.

Spike Camp—See Camp, side.

Spot Burning—A modified form of broadcast slash burning in which only the heaviest accumulations of slash are fired and the fire is not allowed to spread over the entire cut-over area, the object being to reduce the fuels at minimum expense and with much less damage to the residual stand than would occur in a broadcast burn.

Spot Fires—Fires set in advance of or away from the main fire by firing sparks or embers.

Station, Cooperative Weather—An installation of meteorological instruments operated daily and yearlong by non-Weather Bureau personnel, reports being submitted monthly to the U. S. Weather Bureau.

Station, Fire-Danger—A forest station specially selected, equipped, and operated to measure the daily variable factors of fire danger. See Danger, variable.

Station, Fire-Weather—A forest meteorological station specially equipped and operated cooperatively with the U. S. Weather Bureau for measuring weather elements that have an important effect on fire control, forecasting climatological surveys, and research.

Statistical Fire—In national forest practice, a fire which is suppressed, wholly or in part by Forest Service employees or cooperators on which action is taken either to prevent the fire from spreading to or burning over national forest or other lands for which the Forest Service assumes protection responsibility. (Suppression action must be actual work on the fire itself and fully defensible in respect to the threat of spreading to national forest lands or national forest protected lands.)

Representative examples of nonstatistical fires are as follows:

(a) Fires that have gone out naturally when reached.

(b) Railroad fires confined to the right-of-way which do not endanger Forest Service protected land and are suppressed by railroad employees with or without Forest Service help.

(c) Small fires resulting from legitimate slash or debris burning operations when extinguished by the causative agency.

(d) Abandoned campfires which cannot spread because of the condition of forest fuels or weather conditions or are confined to improved fireplaces or stoves.

(e) Individual incendiary sets when all sets burn together and are suppressed as one fire. In this event all sets will be reported as one fire.

(f) Individual incendiary sets which are suppressed separately, where less than ¼ mile intervenes between any adjacent two sets. Only one fire will be reported in such cases.

(g) Burning buildings, automotive equipment, haystacks, sawdust piles, etc., which under the prevailing conditions are not a menace to Forest Service protected lands.

(h) Fires from any cause confined to private lands which do not endanger Forest Service protected lands and are suppressed by landowners or others responsible for their suppression with or without Forest Service aid.

Sticks, Moisture-Indicator—See Fuel-moisture-indicator sticks.

Straw Boss—See Boss, straw.

Suppression—All the work of extinguishing a fire beginning with its discovery. See Fire control, prevention, presuppression.

Suppression Foreman—A guard in charge of a suppression squad.

Suppression Squad—Two or more men stationed at a strategic location, either regularly or in an emergency, for initial action on fires. Duties are essentially the same as those of individual firemen.

Surface Fire—See Types of fires.

Tangent Offset Method—A method used by firemen to get on line of sight from a lookout to a fire, where a compass shot on the lookout point cannot be obtained except from a point to one side of the line of sight.

Temporary Lookout Station—See Lookout station, temporary.

Test Fire—A controlled fire set with or without the knowledge of the detection organization for the purpose of checking the alertness of lookout men, or the effectiveness of any lookout station. (A smoke candle may be used for the same purpose.) See Smoke candle.

Thermometer, Maximum—See Maximum thermometer.

Thermometer, Minimum—See Minimum thermometer.

Towerman—A lookout man stationed at a tower.

Travel-Time Map—See Map, travel-time.

Trench—Formerly used as a synonym for "fire line" which is the preferred term because a fire line need only be scraped to mineral soil, not a dug way. (See gutter trench which is the only type of fire line which needs to take the form of a ditch in mineral soil.)

Two-Foot Method—See Control-line classification.

Types of Fires:

Crown—A fire that burns through the tops of trees, brush, or chaparral, or which consumes all or a large part of the upper branches or foliage of trees, brush, or chaparral.

Ground—A fire confined to the materials composing the forest floor or beneath the surface as in peat beds. (Usually combined with surface fire but not to be confused with surface fire which burns only the top of the ground cover.)

Surface—A fire that runs over the forest floor burning only the surface litter, the loose debris, and the smaller vegetation or ground cover. See Character of fires.

Variable Danger—See Danger, variable.

Visibility—The character or quality of an object or image with reference to its background and the transparency or clearness of the intervening atmosphere that permits it to be distinguished by the eye.

Visibility, Atmospheric—The relative transparency or degree of clearness of the atmosphere through which objects or smokes are seen.

Visibility Distance—The maximum range of vision in miles at which a lookout man can distinguish a standard or specified size of smoke column under specific atmospheric conditions.

Visibility Meter—An instrument for measuring the dependable range of distance to which a standard smoke column can be detected by the eye under various conditions of haze. Sometimes called "haze meter."

Weather—The state of the atmosphere at any particular time and place with respect to temperature, atmospheric pressure, wind, clouds, relative humidity and precipitation. See Climate.

In the forest-fire weather forecasts issued by the U. S. Weather Bureau, the expected state of the weather is indicated by the following terms:

FORECAST TERMS AND DEFINITIONS

Clear—No precipitation. Sky free or practically free from clouds. (Average for period less than one-tenth of sky covered.)

Scattered—No precipitation. Sky partially clouded. (Average of 1 to 5 tenths of sky covered with clouds.)

Broken—No precipitation. Sky partially clouded. (Average for period more than 5 but not more than 9 tenths of sky covered.)

Overcast—No precipitation. Sky completely overcast or nearly so. (Average for period more than 9 tenths.)

Generally fair—Considerable variation in cloudiness but with tendency for stable, settled weather. Possibility of very light precipitation in widely scattered localities, but no precipitation over most of area.

Increasing cloudiness—No precipitation, but progressive increase in cloudiness, either in amount of sky covered, or in density of cloud layers.

Decreasing cloudiness—No precipitation, but progressive decrease in the amount of sky covered, and/or density of clouds.

Unsettled—Precipitation unlikely, but some possibility of light showers in small, scattered areas. Considerable cloudiness with sky occasionally covered with dark, lowering clouds, and tendency toward instability.

Clearing—Precipitation to end during the time period specified, followed shortly thereafter by clearing sky.

Foggy—No precipitation, but condensation on surface objects. May be modified by terms "Light," "Moderate," "Thick" or "Dense"; or may be expressed as *"Fog and/or low clouds"* when uncertainty exists whether one, the other or both may occur.

Rain or Snow—Precipitation of comparatively long duration as distinguished from showers or flurries. Precipitation expected over a major portion of the area.

Occasional Rain or Snow—Precipitation at infrequent intervals and not prolonged, but widespread.

Intermittent Rain or Snow—Precipitation of more or less general and prolonged character, but frequently interrupted for short periods.

Local Rain or Snow—Precipitation of comparatively long duration over limited portions of the area.

General Rain or Snow—Widespread precipitation of prolonged duration and in amount sufficient to materially reduce fire danger.

Showers or Flurries—Precipitation intermittent and of short duration. May be modified by the terms "General" or "Local" and/or by terms given below.

Drizzle—Precipitation consisting of numerous tiny droplets.

Dew or Frost—Widespread liquid or frozen condensation on surface objects. May be modified by the terms "Light" or "Heavy."

In precipitation forecasts, the following modifying terms may be used:

Very Light—Less than .03 inch precipitation.
Light—Less than .10 inch precipitation.
Moderate—Between .10 inch and .50 inch precipitation.
Heavy—More than .50 inch precipitation.
Very Heavy—More than 1 inch precipitation.

Thunderstorms:

Lightning (thunder may or may not be heard) in connection with cumulus type clouds. Precipitation occurring in the storm may or may not reach the ground. Any of the following terms relating to intensity of the storm, area affected, size of disturbance, amount of precipitation, height of clouds, or chance of occurrence may be used in thunderstorm forecasts.

Terms relating to:

Intensity—

Mild—Less than average intensity.
Moderate—Average storm intensity.
Severe—Considerably more intense than usual.

Extent:

Local—Storms affecting about 30% or less of area.
Scattered—Storms affecting between 30% and 70% of area.
General—Storms affecting about 70% or more of area.

Precipitation:

Very wet—More than 1 inch accompanying rainfall.
Wet—More than .50 inch accompanying rainfall.
Moist—.10 to .50 inch accompanying rainfall.
Dry—Less than .10 inch accompanying rainfall.
Very dry—Less than .03 inch accompanying rainfall.

Chance of Occurrence:

Possibly 40% to 60% chance of occurrence.
Probably 50% to 80% chance of occurrence.

An unqualified thunderstorm forecast indicates better than 80% chance of occurrence.

Temperature:

Terms used in predicting a change in temperature level compared to that of preceding period.

Warmer—Higher temperatures by 6 degrees F. or more.

Colder—Lower temperatures by 6 degrees F. or more.

Terms relating to a progressive temperature change:

Rising—Temperatures becoming progressively higher when compared with corresponding times 24 hours previous (at least 6 degrees F. lower expected by end of period).

Falling—Temperatures becoming progressively lower when compared with corresponding times 24 hours previous (at least 6 degrees F. lower expected by end of period).

Relative Humidity:

Terms related to change in humidity:

Higher—Higher by an amount exceeding the limit of "little change."

Lower—Lower by an amount exceeding the limit of "little change."

Terms related to a progressive change in level:

Rising or Falling—Humidities becoming progressively higher or lower when compared with corresponding times 24 hours previous. (Differences expected to exceed the limit of "little change" by end of period.)

Wind Velocity:

Terms relating to change in wind velocity:

Stronger—Winds stronger by at least 5 m.p.h. than 24 hours previous.

Lighter—Winds lighter by at least 5 m.p.h. than 24 hours previous.

Terms relating to a progressive change wind velocity.

Increasing—Winds becoming progressively stronger during period.

Diminishing—Winds becoming progressively lighter during period.

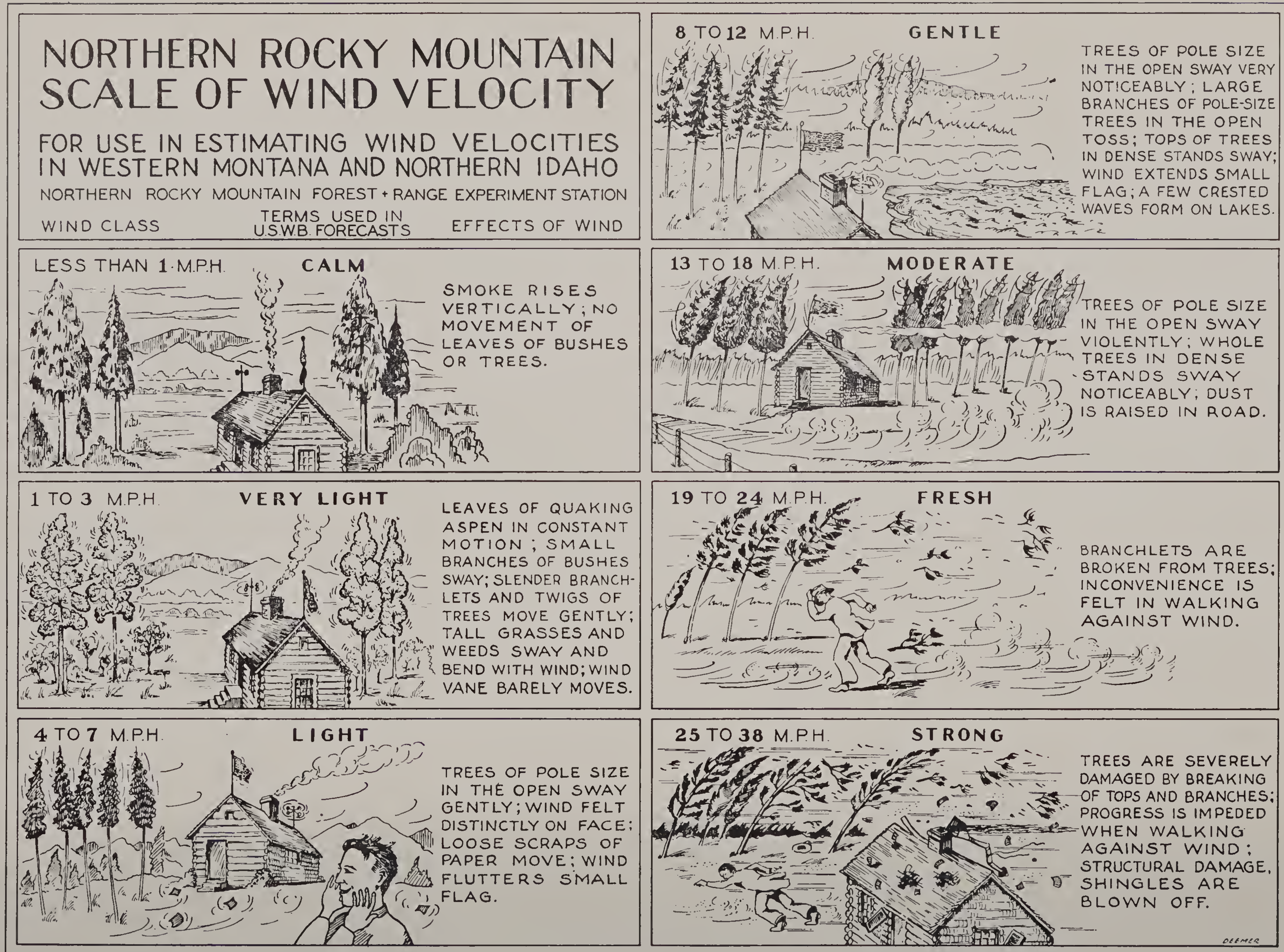
Gusty—Rapid and wide variations in force in short time intervals, may be modified by the terms "Somewhat," "Moderately" or "Very."

Squally—Recurrent blasts of longer duration and less frequent than "gusty," and from a fairly steady direction.

Forecasts of wind force or velocity are made in general terms related to certain group classifications based on Beaufort wind scale deduction. The terms, given below, indicate the approximate average wind velocity expected during the afternoon of the period forecast:

Calm	Less than 1 m.p.h.
Very light	1 to 3 m.p.h.
Light	4 to 7 m.p.h.
Gentle	8 to 12 m.p.h.
Moderate	13 to 18 m.p.h.
Fresh	19 to 24 m.p.h.
Strong	25 to 38 m.p.h.
Gale	39 to 54 m.p.h.

(See Northern Rocky Mountain scale of wind velocity for indices to use in estimating wind velocity in Region One. Shown on next page.)


NORTHERN ROCKY MOUNTAIN
SCALE OF WIND VELOCITY
FOR USE IN ESTIMATING WIND VELOCITIES
IN WESTERN MONTANA AND NORTHERN IDAHO
NORTHERN ROCKY MOUNTAIN FOREST + RANGE EXPERIMENT STATION
WIND CLASS
TERMS USED IN U.S.W.B. FORECASTS
EFFECTS OF WIND
LESS THAN 1 M.P.H.
CALM
SMOKE RISES VERTICALLY; NO MOVEMENT OF LEAVES OF BUSHES OR TREES.
1 TO 3 M.P.H.
VERY LIGHT
LEAVES OF QUAKING ASPEN IN CONSTANT MOTION; SMALL BRANCHES OF BUSHES SWAY; SLENDER BRANCHLETS AND TWIGS OF TREES MOVE GENTLY; TALL GRASSES AND WEEDS SWAY AND BEND WITH WIND; WIND VANE BARELY MOVES.
4 TO 7 M.P.H.
LIGHT
TREES OF POLE SIZE IN THE OPEN SWAY GENTLY; WIND FELT DISTINCTLY ON FACE; LOOSE SCRAPS OF PAPER MOVE; WIND FLUTTERS SMALL FLAG.
8 TO 12 M.P.H.
GENTLE
TREES OF POLE SIZE IN THE OPEN SWAY VERY NOTICEABLY; LARGE BRANCHES OF POLE-SIZE TREES IN THE OPEN TOSS; TOPS OF TREES IN DENSE STANDS SWAY; WIND EXTENDS SMALL FLAG; A FEW CRESTED WAVES FORM ON LAKES.
13 TO 18 M.P.H.
MODERATE
TREES OF POLE SIZE IN THE OPEN SWAY VIOLENTLY; WHOLE TREES IN DENSE STANDS SWAY NOTICEABLY; DUST IS RAISED IN ROAD.
19 TO 24 M.P.H.
FRESH
BRANCHLETS ARE BROKEN FROM TREES; INCONVENIENCE IS FELT IN WALKING AGAINST WIND.
25 TO 38 M.P.H.
STRONG
TREES ARE SEVERELY DAMAGED BY BREAKING OF TOPS AND BRANCHES; PROGRESS IS IMPEDED WHEN WALKING AGAINST WIND; STRUCTURAL DAMAGE, SHINGLES ARE BLOWN OFF.
DEEMER

MODIFYING FORECAST TERMS FOR TEMPERATURE, RELATIVE HUMIDITY AND WIND VELOCITY

Since predictions of these elements are all made in terms of changes, or of indicated specific values, the same modifying terms may be used for all these elements. Accordingly, definitions of such terms as they relate to each element are given in the following tables.

The *first two terms* in each group listed as relating to specific changes (warmer, colder, higher, lower, etc.) may be modified by terms given in the following table, thus specifying the *amount* of expected change.

Modifying term	Temperature	Relative Humidity	Wind Velocity
Slightly	1 degree to 5 degrees F.	1% to 5%	1 to 5 m.p.h.
Somewhat	6 degrees to 10 degrees F.	6% to 10%	6 to 10 m.p.h.
Materially	11 degrees to 15 degrees F.	11% to 15%	11 to 15 m.p.h.
Considerably	16 degrees to 20 degrees F.	16% to 20%	16 to 20 m.p.h.
Decidedly	21 degrees to 30 degrees F.	21% to 30%	21 to 30 m.p.h.
Much	31 degrees F. or more	31% or more	31 m.p.h. or more
Little change	5 degrees or less	5% or less	5 m.p.h. or less

The *last two terms* in each group, listed as relating to progressive changes (rising, falling, etc.) may be modified by the terms:

Slowly or rapidly—to specify the expected *rate* of change.

Maximum or minimum—the forecaster may indicate his estimate of maximum or minimum values for the period by quoting specific figures; or he may indicate the *average* values for the period by using the terms given in the following table.

Term	Temperature	Relative Humidity	Wind Velocity Term	Values
Very high	100 degrees F. or more	Over 80%	Calm	Less than 1 m.p.h.
High	90 degrees to 100 degrees F.	61% to 80%	Very light	1 to 3 m.p.h.
Moderately high	80 degrees to 90 degrees F.	51% to 60%	Light Gentle	4 to 7 m.p.h. 8 to 12 m.p.h.
Moderate	65 degrees to 80 degrees F.	41% to 50%	Moderate	13 to 18 m.p.h.
Moderately low	50 degrees to 65 degrees F.	31% to 40%	Fresh Strong	 25 to 38 m.p.h.
Low	35 degrees to 50 degrees F.	21% to 30%	Gale	39 to 54 m.p.h.
Very low	Below 35 de-degrees F.	11% to 20%	Whole gale	55 to 75 m.p.h.
Acutely low	....	10% or less	Hurricane	Over 75 m.p.h.

Wind Direction:

Wind direction will ordinarily be specified to eight points of the compass FROM which the average regional wind is expected to blow. The direction indicated will embrace an arc of 45 degrees or ⅛ circle centered on the direction quoted. The predicted wind direction is that of the *regional* wind, from which there may be wide local variations due to topographic irregularities. It is possible to make allowances for such local variations only in specific forecasts for small areas.

North	Southeast	West
Northeast	South	Northwest
East	Southwest	

Composite direction indications limited to adjacent directions and covering an arc of 90 degrees may be used, such as "North to Northeast," "Southeast to South," etc., using the above terms as defined.

Another general direction classification covering an arc of 90 degrees may be used as follows:

Northerly	Southeasterly	Westerly
Northeasterly	Southerly	Northwesterly
Easterly	Southwesterly	

Terms indicating a change of direction:

Veering—A progressive change in direction in a clockwise sense.

Backing—A progressive change in direction in a counter-clockwise sense.

Becoming—Indicating a change from one to another specified wind direction.

Topographic winds:

Upslope—A topographic wind due to surface heating during the day, blowing upslope at all points. Commonly occurs during daylight hours, reaching its maximum force usually during mid-afternoon.

Downslope—A topographic wind due to nocturnal cooling and blowing downslope, reaching its maximum force during early morning hours. Most noticeable in valleys, coves, and other natural drainage channels.

Eddies—Eddies in the generally-prevailing wind flow produced mechanically to the leeward of mountain peaks, ridges, etc. May have vertical or horizontal components, but direction is generally different from the regional wind.

Wind direction terms may be modified as follows:

Variable—Uncertain and irregular—usually subject to slow to moderate changes of varying magnitude.

Changeable—Uncertain and irregular changes of direction of a more decided nature and magnitude than "Variable."

Mostly—A modifier used when winds will be subject to some variability, to indicate what direction will predominate.

REVIEW QUESTIONS FOR SECTION IV

SPECIAL METHODS USED BY GUARDS

Use of Compass:

1. What is meant by azimuth?
2. Name three common mistakes to guard against in using a compass.
3. How are azimuths converted into back sight readings?
4. In taking back sight is north or south end of needle read?
5. When starting from lookout, should fireman run compass line continuously from starting point to fire?
6. When after traveling first part of trip in a circuitous route, how may a fireman determine when he is again in line of sight (azimuth)?
7. How may offsets be made while running compass line without materially increasing possibility of error?
8. How does fireman use back sights (azimuths) from two lookouts when searching for fire?
9. Upon nearing the reported location of a fire on which the fireman has azimuths from two lookouts, one lookout is cut off from view by an intervening ridge. How may fireman make use of azimuth from that lookout?
10. Describe a simple method for determining whether to move to right or left when back shot azimuth misses target.

Use of Maps:

1. In what direction do township lines extend? Range lines?
2. How many sections in a township? What is order of numbering?
3. How far is it around the outside edge of four sections?
4. In what way does a fireman use a map in going to and finding a fire?
5. How may a map be oriented without use of a compass?
6. Explain how a fireman may determine his location on the ground with a map only (no compass).
7. How does a fireman locate his position on the map and on the ground by use of compass, protractor and map?
8. What information should be sketched on the fireman map before starting to a fire?
9. In what way can section lines and corners be used in finding a fire?
10. How many paces (yours) in one chain? How many paces (yours) across one section on level ground?

Searching for Fires:

1. When vicinity of fire is reached, and the fire is not immediately found, specify five things to be done without aid of map or compass.
2. Name three things to do with map or compass.
3. What is meant by "gridiron method?"
4. How far apart should trips be in gridironing an area?
5. When gridironing an area, how may assurance against circling be effected?

Measuring Areas of Fires:

1. How should area of a fire be computed? On the basis of actual surface area burned in order that the amount of damage may be accurately determined, or on the basis horizontal or level distances?
2. How should the area of a very irregular shaped fire be measured?
3. What units of measurement are used in computing burned area?

4. What two methods may be used in estimating size of fires a considerable distance away from observer?
5. What is the rule of thumb for estimating perimeter of fires in the general shape of a square, rectangle, circle?

Recording Lightning Strikes:

1. What preparation is made for locating lightning strikes?
2. What information is required in reporting lightning strikes?
3. Why must the exact time of each strike be accurately recorded?
4. How may the distance between the strike and the observer be estimated without intersecting azimuths?
5. A strike is seen. The observer counts from thirteen to twenty-eight before thunder is heard. How far away is the strike?

Instructions for Airplane Deliveries:

1. In selecting site for airplane delivery of materials to be dropped by parachute, which side of fire should be chosen?
2. Which is best location for dropping supplies from an airplane:
   (a) mid-point on side hill
   (b) wide ridge top
   (c) bottom of narrow canyon
3. In describing site selected for dropping operation, what six factors should be mentioned?
4. What type and size of marker is required?
5. If signal smokes are used as markers, how should these be arranged?
6. How may sufficient smoke be creased to serve as a signal?

Inspection:

1. What is the purpose of inspection?
2. How may the inspector increase the value to himself of an inspection?
3. Why should guards conduct a weekly self inspection?
4. How may the guard determine the standard of his own performance in making self inspection?
5. Why should inspection be welcomed by all fire control employees?

Equipment:

1. What is the guard's responsibility in regard to equipment assigned to his use?
2. How does extravagant or wasteful use of equipment and supplies directly effect the length of the guard's employment and the number of guards employed?
3. What defects are looked for when inspecting tools in a fireman's pack (axe pulaskis, shovel, canteen, file, compass, map)?
4. How should flashlight head sets be safeguarded against battery drain when not in actual use?
5. How far from the cutting edge of an axe bit should the sharpening bevel extend?

Communication:

1. List five things which may be responsible for failure of telephone bell to ring.
2. Name three things which may prevent your telephone bell from ringing.
3. What are three things which may prevent your being heard by phone on other end of the line?

4. Specify three things which may prevent your hearing voices from other end of the line.
5. What are three causes for intermittent, broken or interrupted conversation on line? (Only parts of conversation can be heard.)
6. In maintaining telephone line, how high should wire normally be above ground?
7. What effect do poor splices have on line?
8. When should a guard adjust telephone ringers?
9. When should a guard oil the working parts of his telephone?
10. Why is it necessary to have an up-to-date call card posted near the telephone at all times?

Safety and First Aid:

1. How should severe burns be treated?
2. What common treatment may be given insect bites?
3. How should ticks, which have fastened themselves to the body, be removed?
4. What should be done in the case of broken bones?
5. What is first aid treatment for patient overcome by smoke?
6. What is objective in first treatment for internal poisoning? What four ways may this be accomplished?
7. In what position should persons be placed who are suffering from severe shock? (a) Where face is red? (b) Where face becomes white or pallid?
8. In treating for snake bite, specify five things which must be done and the order in which they are handled.
9. Should stimulants be given to patients suffering from snake bite?
10. How are wounds treated which do not bleed freely?
11. What is treatment for arterial bleeding?

Safety Rules:

1. During lightning storms where is safest place for guard on a lookout?
2. Where is safest refuge during lightning storms when caught away from lookout? In open grass park, on ridge top, in dense timber or in deep canyon?
3. Specify three things that should be done to safeguard lookout house against lightning strikes before each storm.
4. What precautions against fire should be maintained in lookout house?
5. Why is storage of gasoline inside lookout house prohibited?

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